Lesson One

Noise Legislation, Regulations and Policies

Source: www.keyclub.org

So…. How Did All This Noise Stuff Begin?

1. National Environmental Policy Act (NEPA) of 1969

2. Federal-Aid Highway Act of 1970

3. The highway traffic noise related aspects of each of these pieces of legislation are contained in Title 23 Code of Federal Regulations (CFR) Part 772

National Environmental Policy Act (NEPA) of 1969

- Declares a national environmental policy
- Incorporation of environmental considerations by Federal agencies & actions
- Oversight by Council on Environmental Quality (CEQ)
- Categorical Exclusions/Environmental Assessments/Environmental Impact Statements

Source: www.energy.gov

Federal–Aid Highway Act of 1970

- Section 136(b) of the Federal-Aid Highway Act of 1970, Section 109(i), Title 23 U.S.C. requires the establishment of standards for highway noise levels by the Federal Highway Administration (FHWA)

- The 1st Federal legislation to address traffic noise, and resulted in…..

Title 23 Code of Federal Regulations (CFR) Part 772

- Title: “Procedures for Abatement of Highway Traffic Noise and Construction Noise”
- Simply known as “23 CFR 772” or “the Federal Regulation”
- July 13, 2010 (latest version)

Applicability of 23 CFR 772

- Applies to all Federal or Federal-Aid Highway Projects authorized under Title 23 United States Code (USC).

- Applies to any highway project that:
  - Requires FHWA approval, regardless of funding sources
  - Is funded with Federal-Aid highway funds
  - Is funded for all phases solely with FL state funds (Florida Statute (FS) 335.17)

More Applicability of 23 CFR 772

- The state highway agency shall develop a noise policy in conformance with 23 CFR 772, and apply uniformly
- Applies to Type I, Type II & Type III Projects (to be defined later)

Key Elements of 23 CFR 772

- Purpose: Provide procedures for noise studies and abatement measures
- Establish Noise Abatement Criteria (NAC)
- If impacts are identified, abatement measures MUST be CONSIDERED

Key Elements of 23 CFR 772 (Continued)

- Identify reasonable and feasible noise abatement measures that are likely to be incorporated into the project
- Identify traffic noise impacts that can't be reduced or eliminated (those that do not benefit from abatement and why)
- Consider the viewpoints of the property owners and residents that are benefitted by the abatement measure

Key Elements of 23 CFR 772 (Continued)

- FHWA will NOT approve project plans and specifications unless feasible and reasonable noise abatement measures are included (abatement measures must be constructed with project)
- Provide noise contours to local officials
- Third-Party funding not allowed to achieve abatement reasonableness

Even More Key Elements of 23 CFR 772

- The FHWA's Traffic Noise Model (TNM) 2.5 (or most recent) must be used
- Identify construction noise impacts and possible abatement measures

Type I, II and III Projects

Type I Project Examples:

- Construction of a highway on a new location
- Physical alteration of an existing highway, with either:
  - Substantial horizontal alteration
  - Substantial vertical alteration
- Capacity expansion (e.g.: addition of through lanes)

Type I Project Examples (Continued)

- Addition of an auxiliary lane (except when functioning as a turn lane), including:
  - Auxiliary lanes used as through lanes on local roads
  - Auxiliary lanes on freeways connecting two or more interchanges (continuous lanes)
- Addition or relocation of interchange lanes or ramps added to a quadrant to complete an existing partial interchange
- Increasing capacity to existing interchange ramp by adding lanes, including merge lanes

Type I Project Examples (Continued)

- Lengthening or re-alignment of existing interchange ramp acceleration or deceleration lane and associated merging into mainline, where any ramp segment reduces the distance to the closest receptor by one-half
- Restriping existing pavement for the purpose of adding a through-traffic lane or auxiliary lane
- The addition of a new, or substantial alteration of a weigh station, rest stop, ride-share lot or toll plaza
- Addition of ramps or new lanes serving as bus/truck climbing lanes

Type I Projects – the "Kicker"

If a any part of project is determined to be a Type I project under this definition, then entire project area as defined in the environmental document is a Type I project.

Type II Projects

A Type II project is a State, Federal or Federal-Aid highway project for noise abatement on an existing highway (no improvements are being proposed).

- Can also be know as “Retrofit” projects
- Are optional
- FDOT does not have a Type II program

Type III Projects

- A Federal, Federal-Aid, or state-funded highway project that does not meet classification of a Type I or Type II project. Type III projects do not require a noise analysis.

Type III Project Examples:

- Bicycle and pedestrian lanes/paths/facilities
- Activities included in the FDOT highway safety plan
- Landscaping (including the removal of existing vegetation)
- Installation of fencing, signs, pavement markings, small passenger shelters, traffic signals and railroad warning devices
- Deployment of electronics, photonics, communications, or information processing (ITS)
- Resurfacing/restoration/rehabilitation/reconstruction
- Placement of overhead gantries to collect tolls (as long as no disruption to existing traffic patterns)

What Project Type am I?

Project Activity	Project Type		
	I	II	III
Construction of a multi-use trial			
Noise barrier construction to resolve community complaints			
Addition of a through-lane to an interstate			
Installation of ITS equipment			
Construction of a new roadway			
Construction of a grade-separated interchange			
Construction of turn lanes and through-lanes on an arterial			
Roadway resurfacing			
Lengthening of an acceleration lane for an on-ramp			

What Project Type am I?

Project Activity	Project Type		
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Construction of a multi-use trial			X
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Addition of a through-lane to an interstate			
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Roadway resurfacing			X
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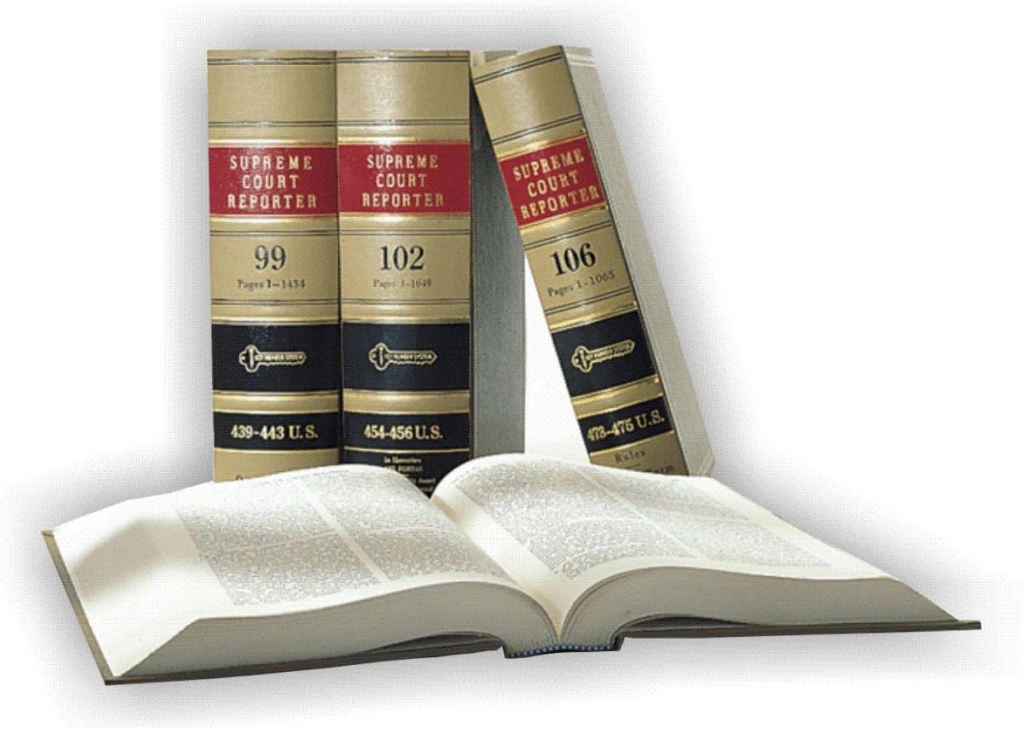
FHWA Noise Abatement Criteria (NAC)

Activity Category	Activity Criteria [1]		Evaluation Location	Activity Description
	Leq(h)	L_{10}(h)		
A	57	60	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67	70	Exterior	Residential
C	67	70	Exterior	Active sports areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreational areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52	55	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E	72	75	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	--	--	--	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	--	--	--	Undeveloped lands that are not permitted.

Florida Regulations Related to Traffic Noise

- Florida Statute (FS) 335.17
- FS 335.02(4)
- FS 479.2
- FS 339.09(1)



FS 335.17
State Highway Construction; Means of Noise Abatement

- 1st law to address traffic noise and abatement in FL
- Applies to all projects by FDOT regardless of funding
- Follow requirements of 23 CFR 772

FS 335.02
Application of Local Regulations

- "Regulations of any county, municipality, or special district, including any instrumentality thereof, shall not apply to existing or future transportation facilities, or appurtenances thereto, on the State Highway System."

- Passed in 2003

FS 479.25
Erection of noise-attenuation barrier blocking view of sign

- If an FDOT noise barrier will block a lawfully erected sign; FDOT must perform the following:
  - Conduct a survey of the benefited property owners
  - Have a public hearing
  - Coordinate with local government

FS 339.09(1)
Use of Transportation Tax Revenues; Restrictions

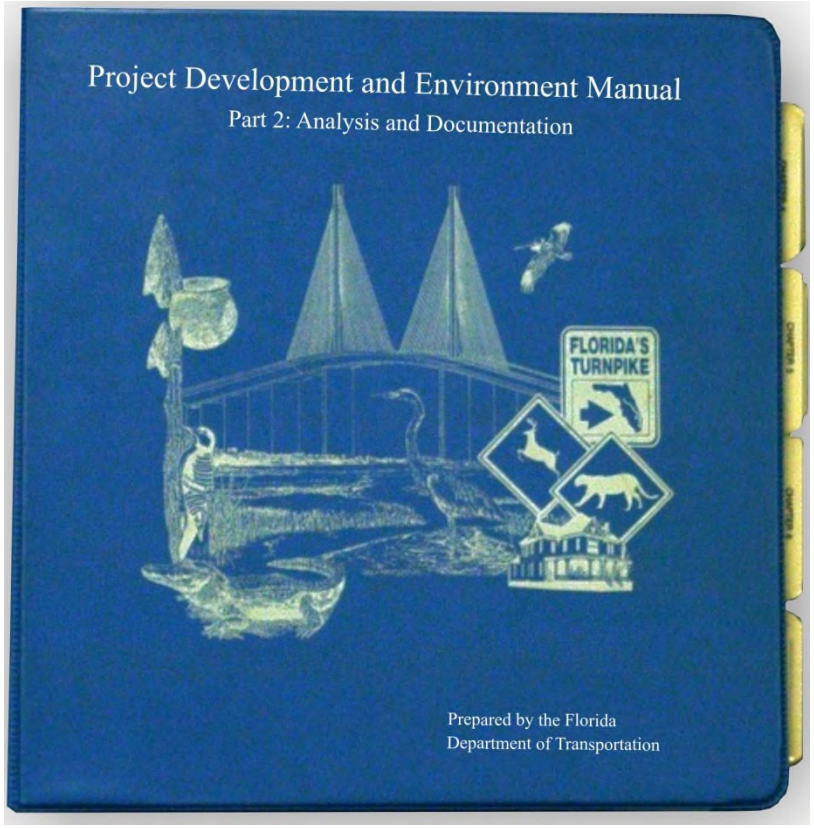
- "……Funds available to the department for any non-transportation purpose…..The department is encouraged and permitted to use funds to construct and maintain noise mitigation facilities or walls upon request of the proper authorities."

Local Noise Ordinances

- Local ordinances vary widely in their approach to noise control
- Frequently have boundary limits
- Often have different criteria for day and night noise levels
- Often limit construction noise
- May contain varying criteria
- May or may not have provisions for variances

FDOT Noise Abatement Policy

- Chapter 17 (Noise) of the FDOT Project Development & Environment (PD&E) Manual is the official noise policy and procedures for the purpose of meeting the requirements of 23 CFR 772 and applicable state laws.

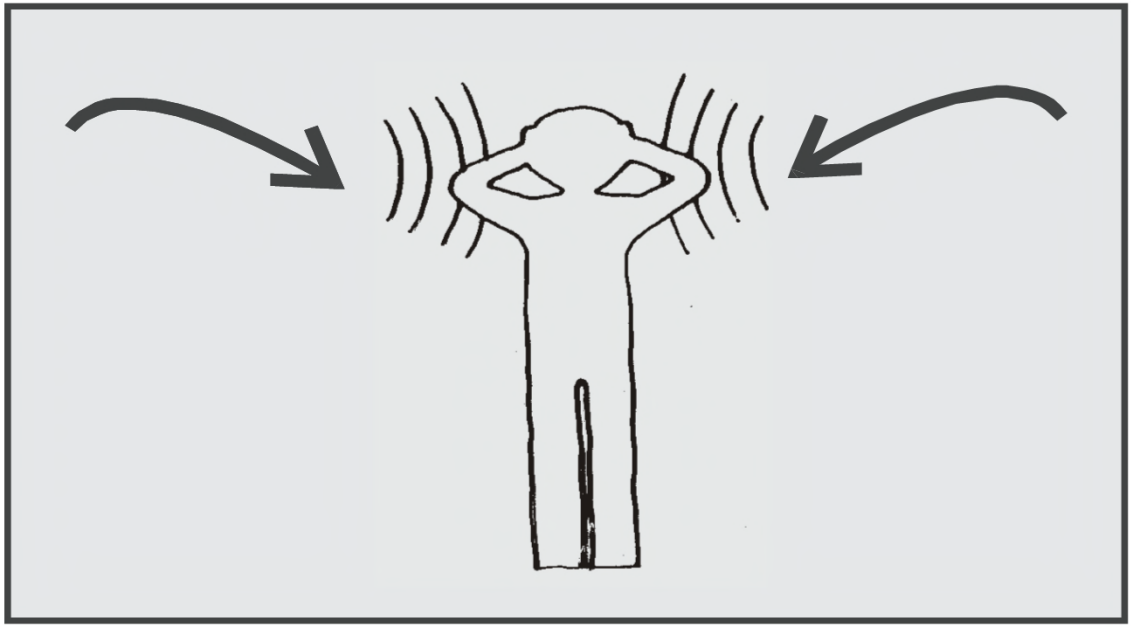


QUESTIONS?

Lesson Two

Basic Acoustic and Traffic Noise Concepts

What is Noise?



- Noise is unwanted sound

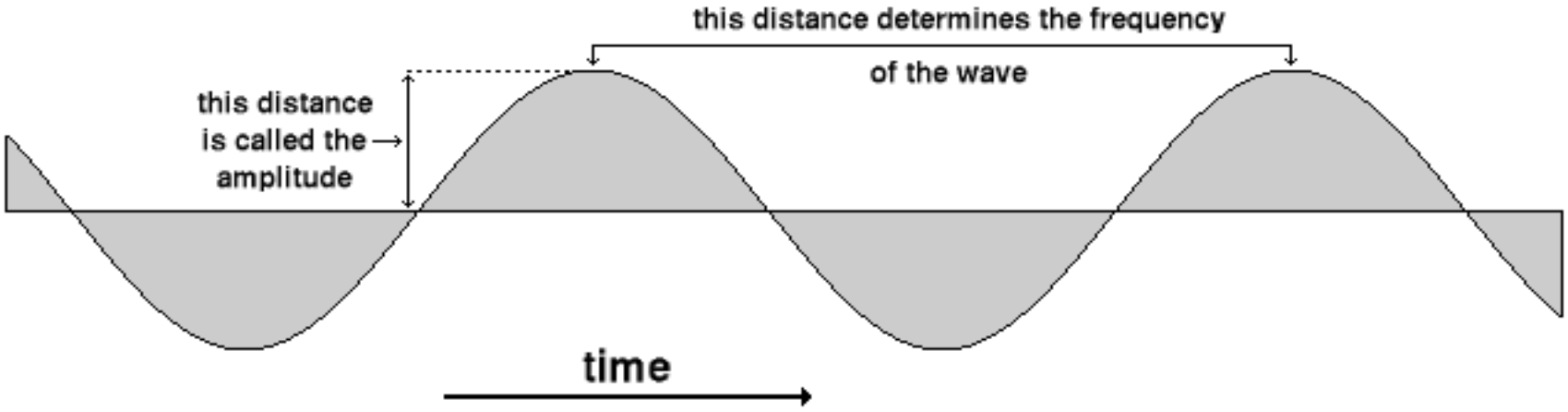
Which probably begs the question…..

What is sound?

Sound is the sensation produced by stimulation of the organs of hearing by vibrations transmitted through the air or other medium. (From: www.dictionary.com)

3 Basic Dimensions of Sound:

- **Magnitude/Amplitude (the "loudness")**
  - Frequency (the "pitch")
  - Time (both duration and variation)



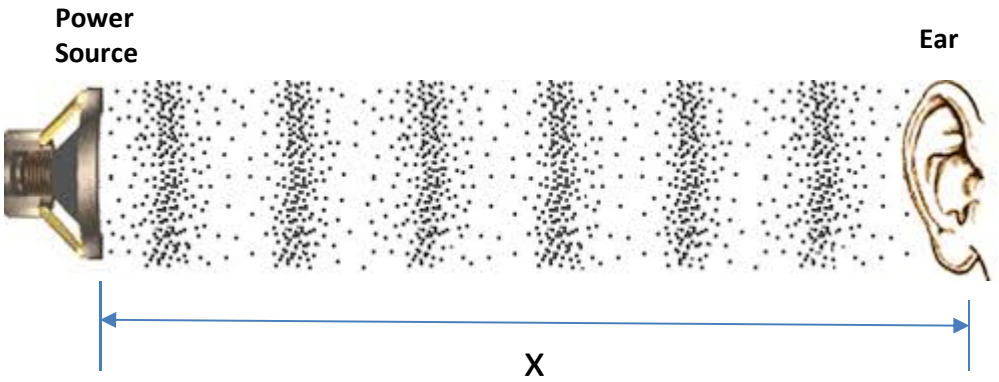
Magnitude is what can be measured – the "loudness"

- Concepts:

Sound/Acoustic Power – The sound energy emitted per unit of time. The power of a sound source on a surface or medium (air).

Sound Pressure – The sound measured at a point in space (x) distance from the source to a "receptor".

Sound Power is the source – Sound Pressure is the effect



The best way to express differences in power is to express it as a ratio of the change with a reference power:

$$\frac{W_1}{W_0}$$

W_1 is power from a power source
W_0 is the reference power

Since the sound power is proportional to the square of the sound pressure:

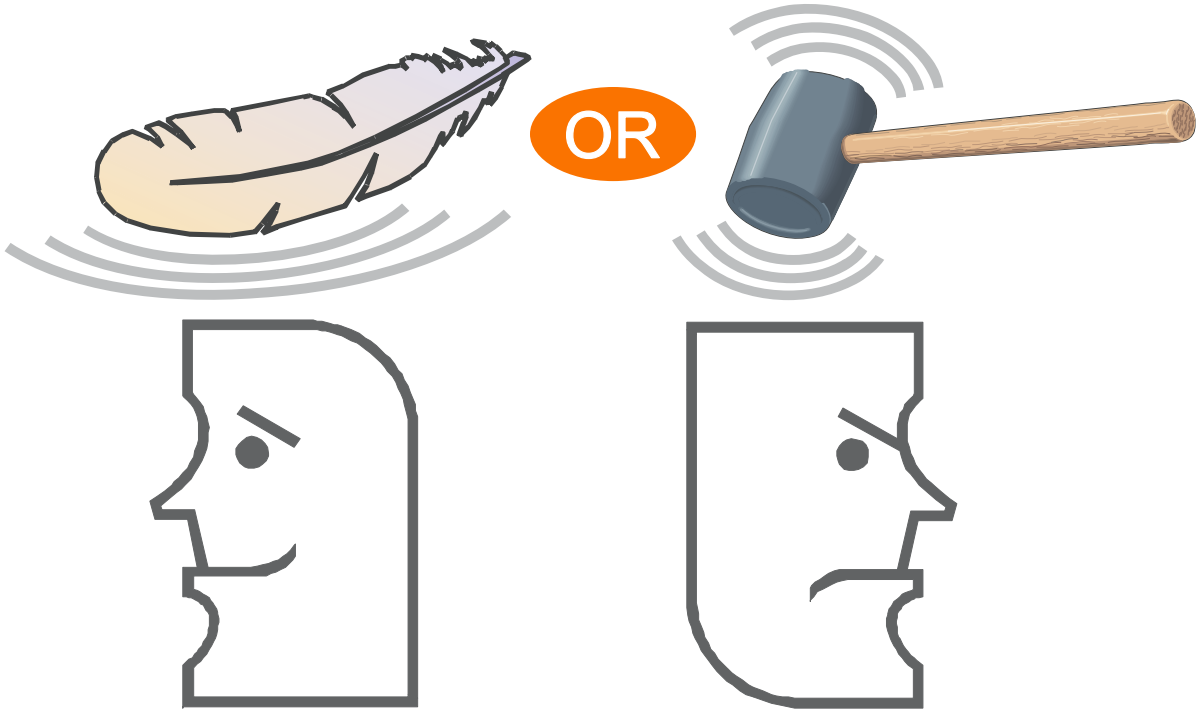
$$\frac{P_1^2}{P_0^2} = \left(\frac{P_1}{P_0}\right)^2$$

P_1 is a sound pressure created by a power source
P_0 is the reference pressure

P_0 is standardized as 20 µPa as the reference sound pressure in air – the threshold of human hearing.

What we are trying to express is

- A Difference Between Pressures, like…..



To give you an idea of what the standardized sound pressure is:

$1\ Pa = 1\ N/m^2 = 1kg \bullet m/sec^2 = .00014504\ lbs/in^2$

$1\ \mu Pa = 1\ X\ 10^{-6}\ Pa$ $20\ \mu Pa = 20\ X\ 10^{-6}\ Pa$

$*20\ \mu Pa = .00002653\ lbs/in^2$

*Threshold of hearing - roughly the sound of a mosquito flying 3 m (10 ft) away

Not only are ratios used to reduce big numbers into manageable numbers…

The logarithms of those ratios are used to express the ratios in levels.

Taking the common logarithm ($\log_{10}$) of the previous ratio, sound pressure levels are expressed in terms of the reference sound pressure in bels (Alexander Graham Bell) by the following formula:

Sound Pressure Level (SPL)= $\log_{10}\left(\frac{P_1}{P_0}\right)^2$ bels

Since a decibel is 1/10 of a bel our final formula is….

$$\text{Sound Pressure Level (SPL)} = 10 \log_{10} \left(\frac{P_1}{P_0}\right)^2 \text{dB}$$

Where:

P_1 is a sound pressure

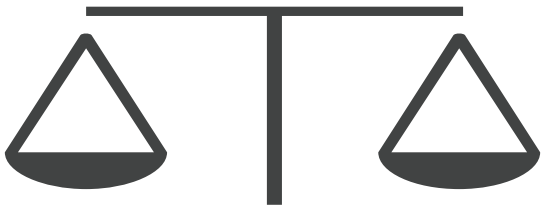
P_0 is a reference pressure, standardized as 20 μPa

Source: CALTRANS Technical Noise Supplement (TENS), 1998

A decibel is a unit of level which denotes the ratio between two quantities that are proportional to power.

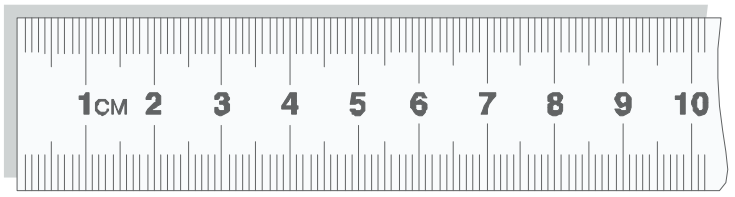
A Decibel is……***Not an Amount like:***

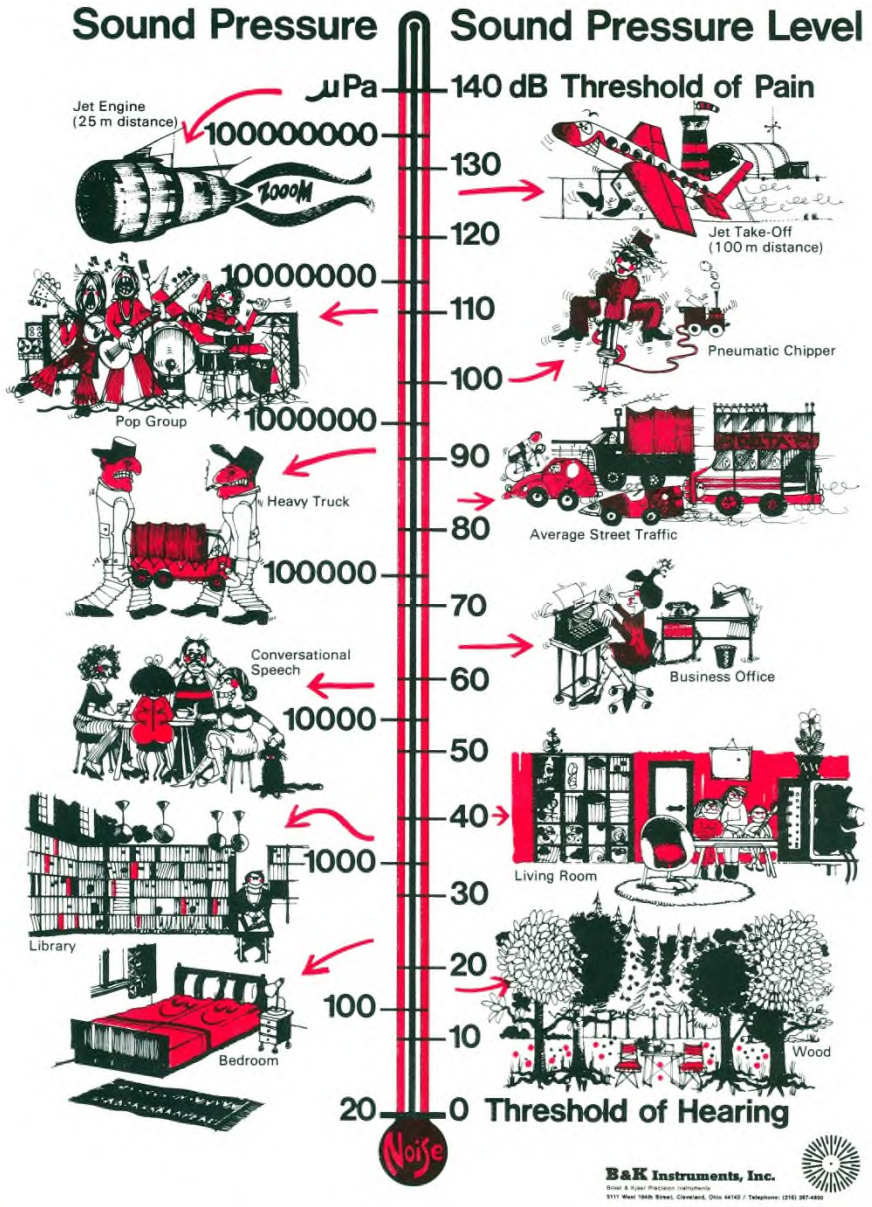
A WEIGHT



OR

A DISTANCE




Sound Pressure
μPa
Sound Pressure Level
140 dB Threshold of Pain
Jet Engine
(25 m distance)
100000000
130
Jet Take-Off
(100 m distance)
120
10000000
110
Pneumatic Chipper
100
Pop Group
1000000
90
Heavy Truck
80
Average Street Traffic
100000
70
Business Office
Conversational
Speech
60
10000
50
40
Living Room
1000
30
Library
20
100
10
Bedroom
Wood
20
0 Threshold of Hearing
Noise
B&K Instruments, Inc.

Sound Level Meters – designed to give readings of sound pressure levels.

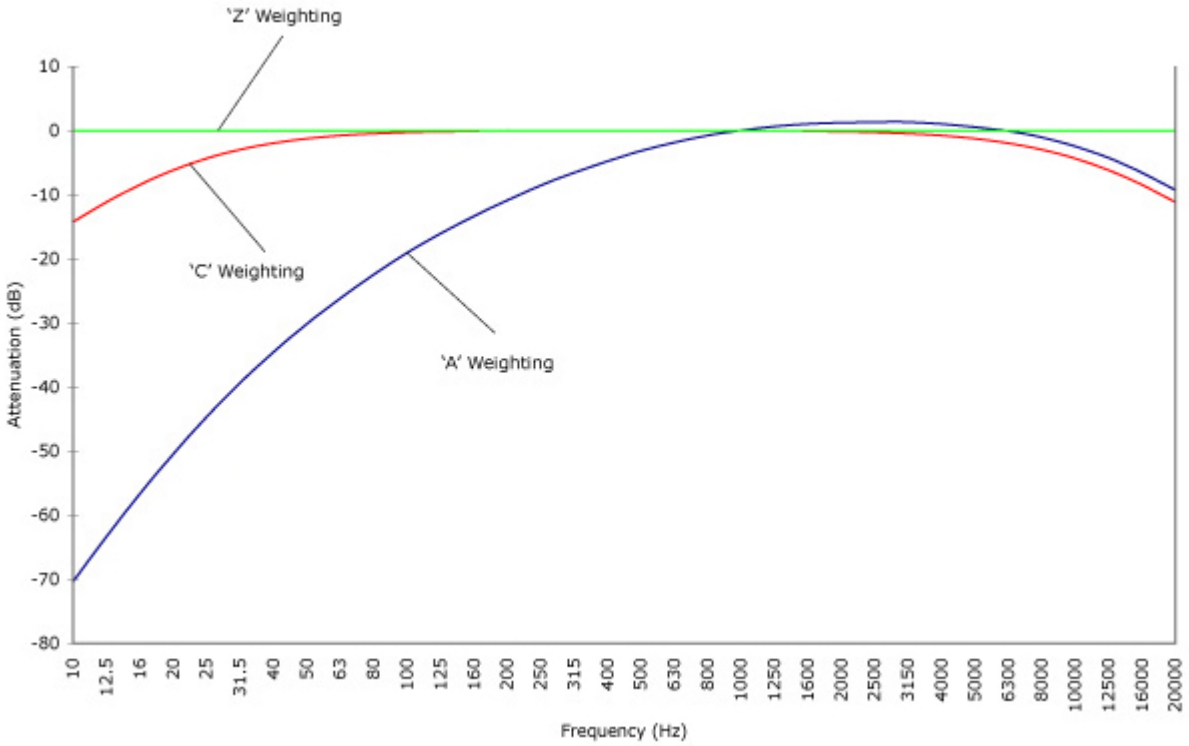
Sound Level Meters offer a selection of frequency weighting networks designated as A, B, C, D and Z.

The human ear is much more sensitive to midrange frequencies between 1,000 Hz and 6,300 Hz (although human hearing covers the frequency range of 20 Hz to 20,000 Hz) – it's less sensitive to very low or very high pitch sounds.

Depending on the weighting network, the meter adjusts the measurements to ensure it is measuring what you actually hear.

A-weighting is the frequency weighting network used to account for changes in sensitivity as a function of frequency. This weighting network most closely approximates the way the human ear perceives sound.

Comparison of A, C, and Z Weighting



The meter adjusts Sound Pressure Levels (SPLs) up or down based on the frequency (and weighting filter).

Comparison of Decibel Changes, Loudness, and Energy Loss

Sound Level Change	Relative Loudness	Acoustic Energy Loss
0 dB(A)	Reference	0
-3 dB(A)	Barely Perceptible Change	50%
-5 dB(A)	Readily Perceptible Change	67%
-10 dB(A)	Half as Loud	90%
-20 dB(A)	1/4 as Loud	99%
-30 dB(A)	1/8 as Loud	99.9%

Source: Highway Traffic Noise: Analysis and Abatement Guidance (FHWA, 2010)

How are decibels added?
(Because 50 dB + 50 db DOES NOT = 100 dB)

When two decibel values differ by:	Add the following to the HIGHER value:	Example
0 or 1 dB	3 dB	70 dB + 69 dB = 73 dB
2 or 3 dB	2 dB	74 dB + 71 dB = 76 dB
4 to 9 dB	1 dB	66 dB + 60 dB = 67 dB
10 dB or more	0 dB	65 dB + 54 dB = 65 dB

Now let's try adding the following decibel levels together:

75 dB

68 dB

88 dB

82 dB

79 dB

?? dB Total

The first step is to put the decibels in order from lowest to highest as shown here:

68 dB

75 dB

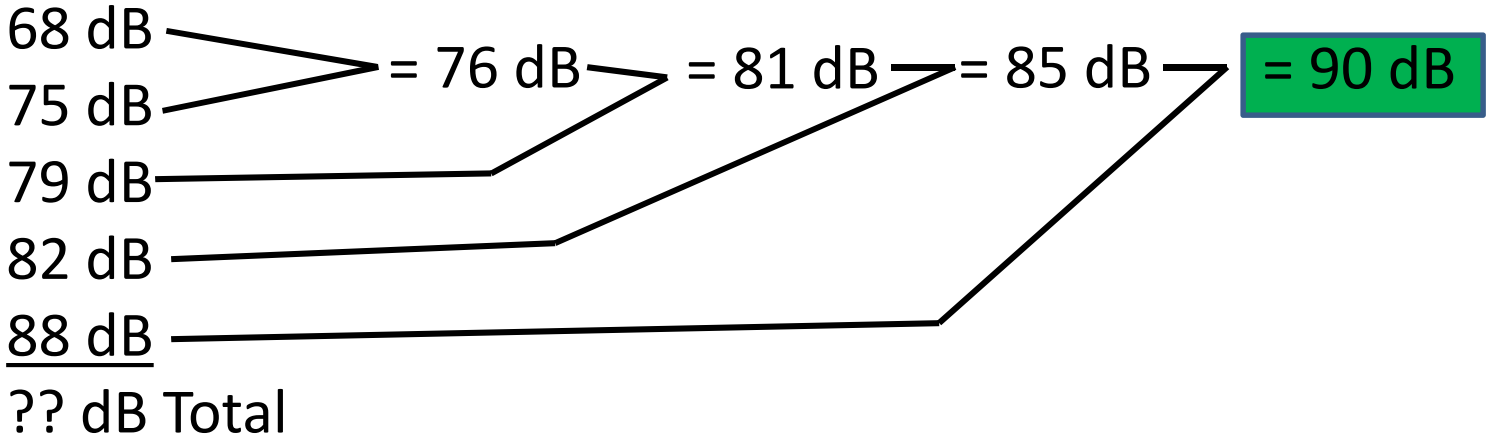
79 dB

82 dB

88 dB

?? dB Total

Next, begin adding the values in pairs, beginning with the smallest two levels:

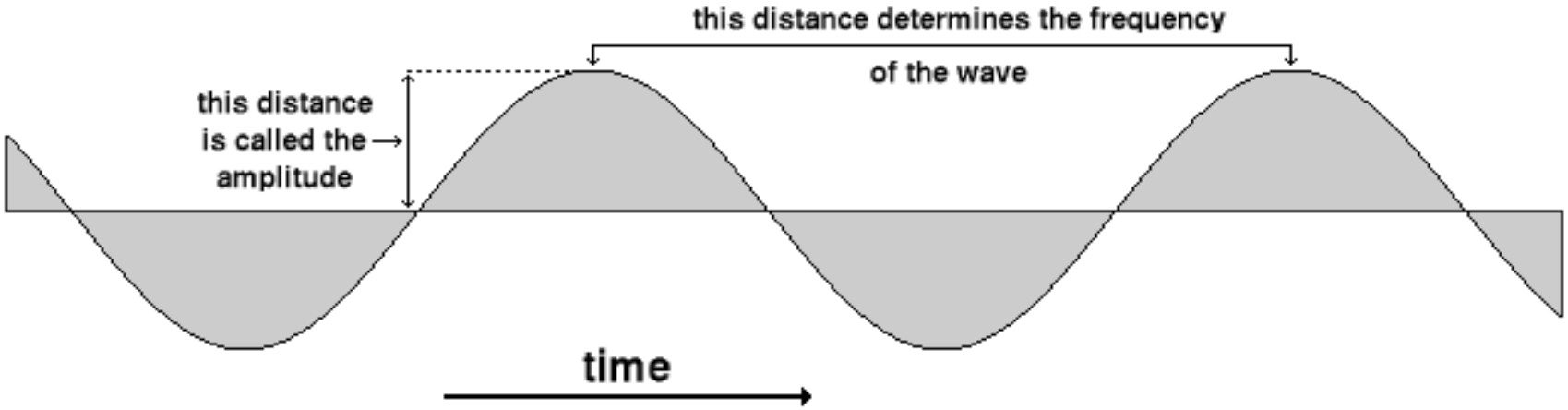


3 Basic Dimensions of Sound:

- Magnitude (the “loudness”)
- **Frequency (the “pitch”)**
- Time (both duration and variation)

Frequency is the number of cyclical crests\variations (wavelengths) per unit of time. Frequency is generally expressed in cycles per second, also denoted as Hertz (Hz).

Source: Noise Control Reference Handbook, 1989

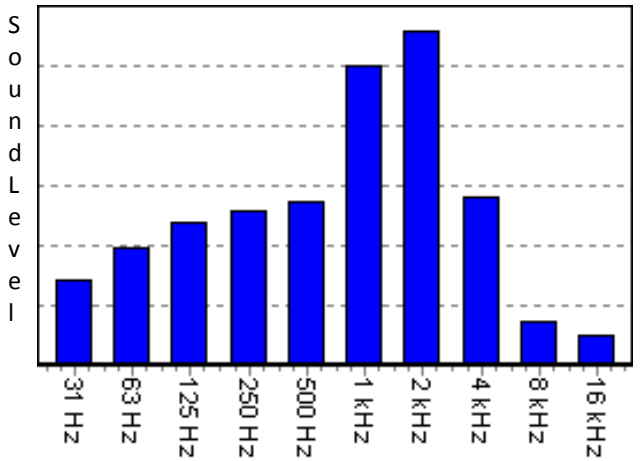


Octaves and Octave Bands

- **Octave:** The interval between two points where the frequency at the second point is twice the frequency of the first.

- **Octave bands:** Used to group frequencies into “bands” or ranges

- Provides a more detailed description of the sound’s character



Source: www.noisemeters.com

3 Basic Dimensions of Sound:

- Magnitude (the “loudness”)
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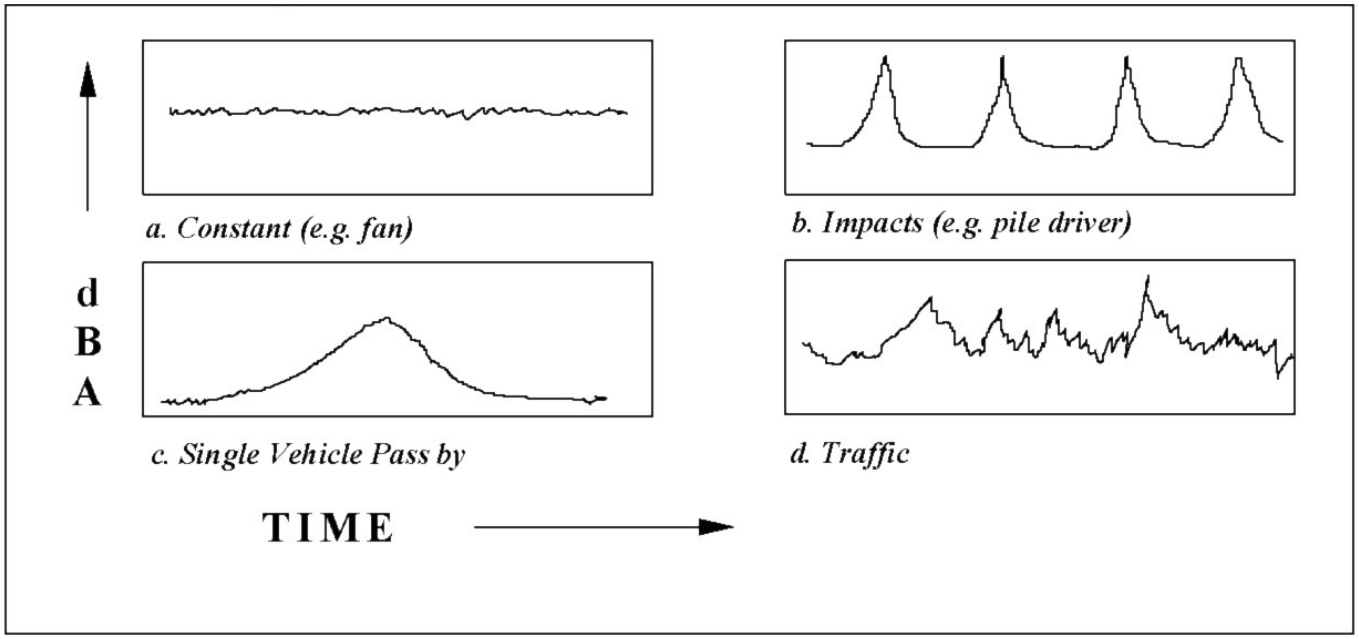
Noise is described based on its sound intensity over a given period of time.

This is illustrated here:



Source: CALTRANS Technical Noise Supplement, 1998

Sound Level Descriptors

- Descriptors are the various metrics (can also be called “measures”) used to describe noise under various conditions.

NOISE DESCRIPTOR	DEFINITION
L_{MAX} (Maximum Noise Level)	The highest instantaneous noise level during a specified time period. The use of "peak" level should be discouraged because it may be interpreted as a non-r.m.s. noise signal.
L_X (A Statistical Descriptor)	The noise level exceeded X percent of a specified time period. The value of X is commonly 10. Other values of 50 and 90 are sometimes also used. *Examples:* L_{10}, L_{50}, L_{90}
L_{eq} (Equivalent Noise Level. Routinely used by FDOT and FHWA to address the worst noise hour) ($L_{eq}(h)$)	The equivalent steady state noise level in a stated period of time that would contain the same acoustic energy as the time varying noise level during the same period.

Source: CALTRANS Technical Noise Supplement, 1998

NOISE DESCRIPTOR	DEFINITION
L_{dn} (Day - Night Noise Level. Used commonly for describing community noise levels).	A 24-hour L_{eq} with a "penalty" of 10 dBA added during the night hours (2200 - 0700). The penalty is added because this time is normally sleeping time.
CNEL (Community Noise Equivalent Level. A common community noise descriptor, also used for airport noise).	Same as the L_{dn} with an additional penalty of 4.77 dBA, (or 10 Log 3), for the hours 1900 to 2200, usually reserved for relaxation, TV, reading and conversation.
SEL (Single Event Level. Used mainly for aircraft noise, it enables comparing noise created by a loud, but fast overflight, with that of a quieter, but slow overflight).	The acoustical energy during a single noise event, such as an aircraft overflight, compressed into a period of one second, expressed in decibels.

Source: CALTRANS Technical Noise Supplement, 1998

So Which Descriptor Does the FDOT Use and Why?

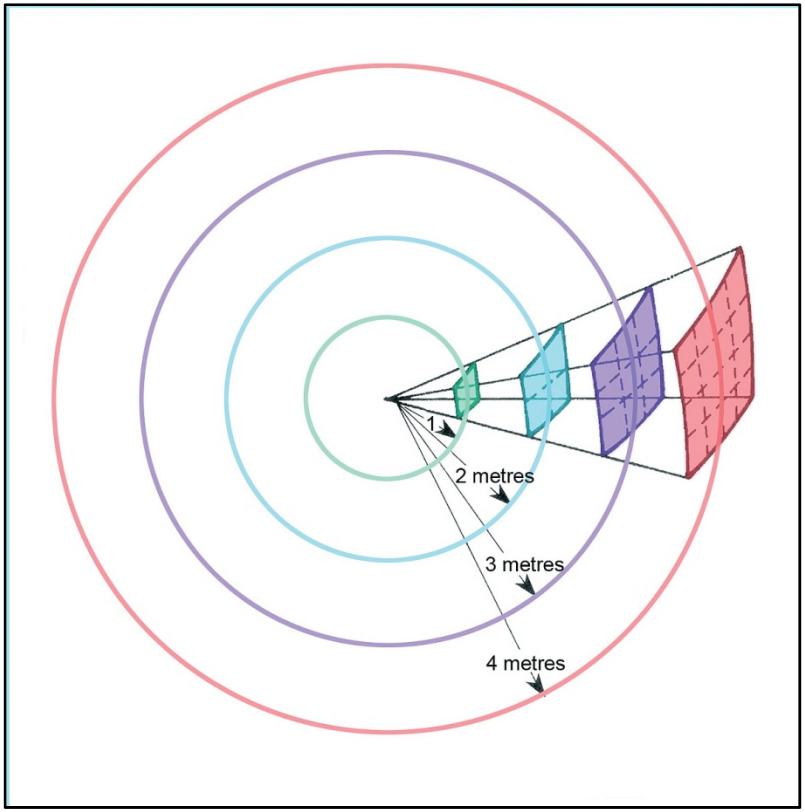
FDOT uses the descriptor Leq(h) to describe highway traffic noise.

What is sound propagation?

- The manner in which sound travels through a compressed medium (such as air)

➢ Propagation is Influenced By…..

- Geometric spreading from point and line sources
- Ground Effects
- Atmospheric Effects
- Shielding (by both natural and man-made features)

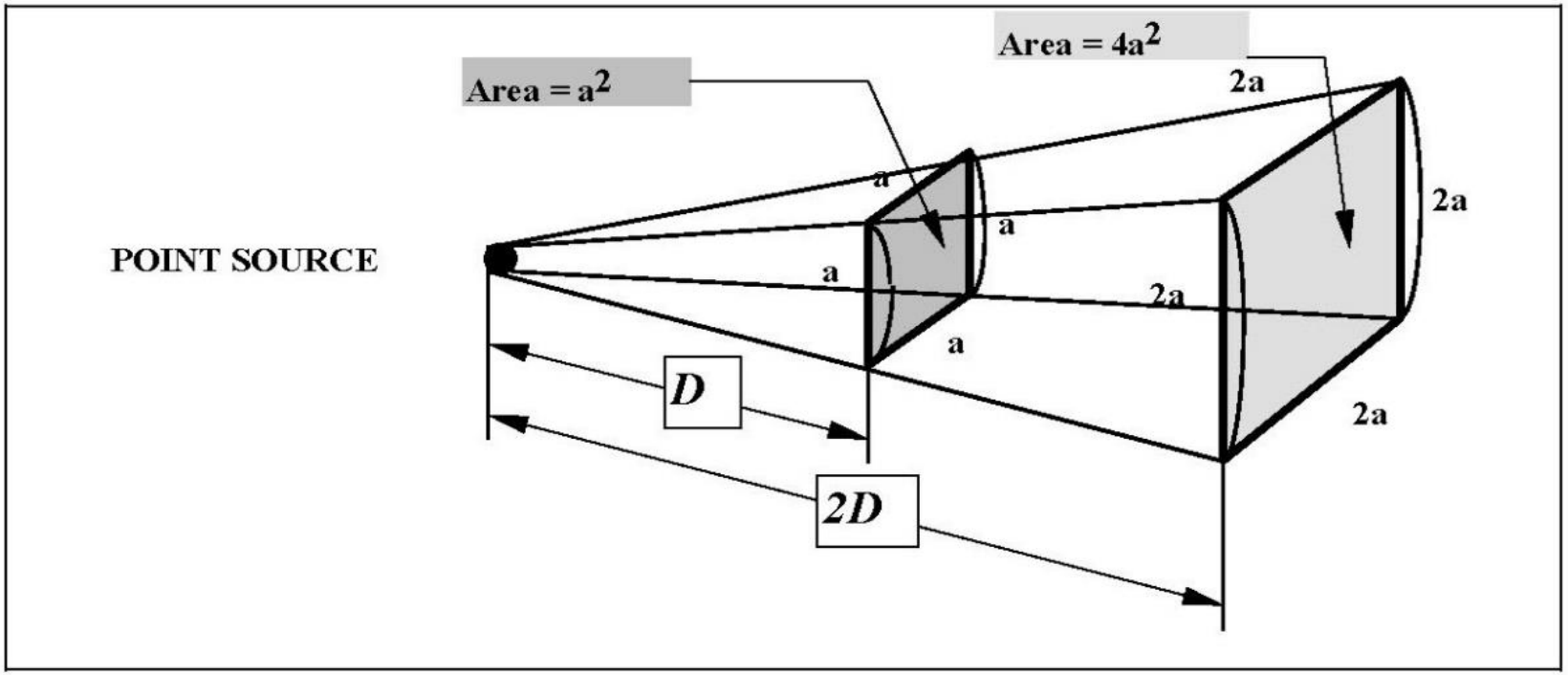


Source: www.performing-musician.com

Geometric Spreading – 2 Primary Types:

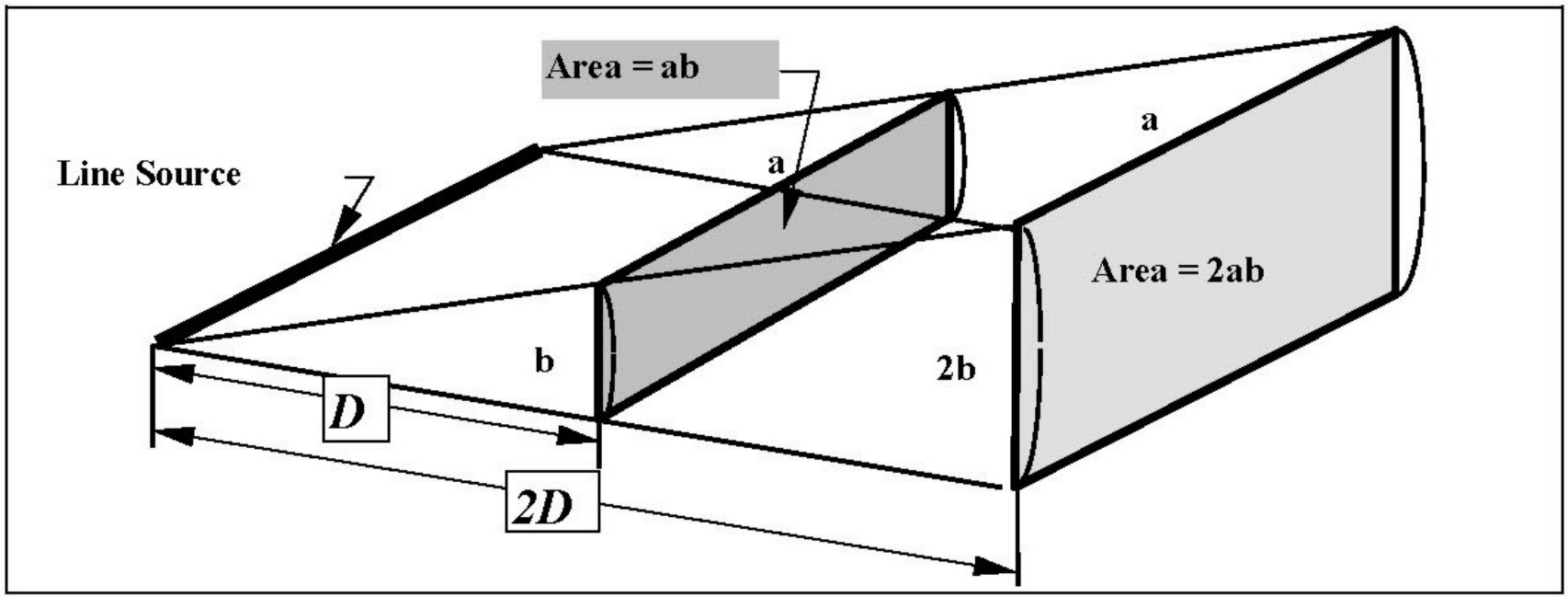
- Spherical Spreading (From a point source)
- Cylindrical Spreading (From a line source)

A point source radiates outward uniformly from the source in a spherical pattern. The sound level attenuates (decreases) at a rate of 6 dB(A) for each doubling of the distance from the source.



Source: CALTRANS Technical Noise Supplement, 1998

A line source (such as highway traffic) makes the sound appear to emanate from a line rather than a point, which results in cylindrical spreading. The sound level attenuates at a drop-off rate of 3 dB(A) for each doubling of distance.



Source: CALTRANS Technical Noise Supplement, 1998

Ground absorption is how the ground surface tends to absorb or reflect traffic noise. There are two general classifications for the ground surface type:

- Hard Sites
- Soft Sites

A “Hard Site” is a reflective ground surface between the source and the receptor, such as:

- Parking Lots (Concrete, asphalt, etc.)
- Water

The “Hard Site” drop-off rate is typically considered to be 3 dB per doubling of distance.

A “Soft Site” is an absorptive ground surface between the source and the receptor, such as:

- Grass/Lawn
- Loose Soil
- Snow

The “Soft Site ” drop-off rate is typically considered to be 4.5 to 6 dB per doubling of distance.

Calculate the noise level from a **Point Source** to a receptor 200 feet away if the noise level at 50 feet is 76 dB(A). (Assume the ground surface is “soft”, with a drop off rate of 6 dB per doubling of distance).

- 100 feet = 70 dB(A)
- 200 feet = 64 dB(A)

Let's try another one…..

Calculate the noise level from a **Line Source** to a receptor 400 feet away if the noise level at 50 feet is 76 dB(A). (Assume this is a hard site with a drop off rate of 3 dB per doubling of distance).

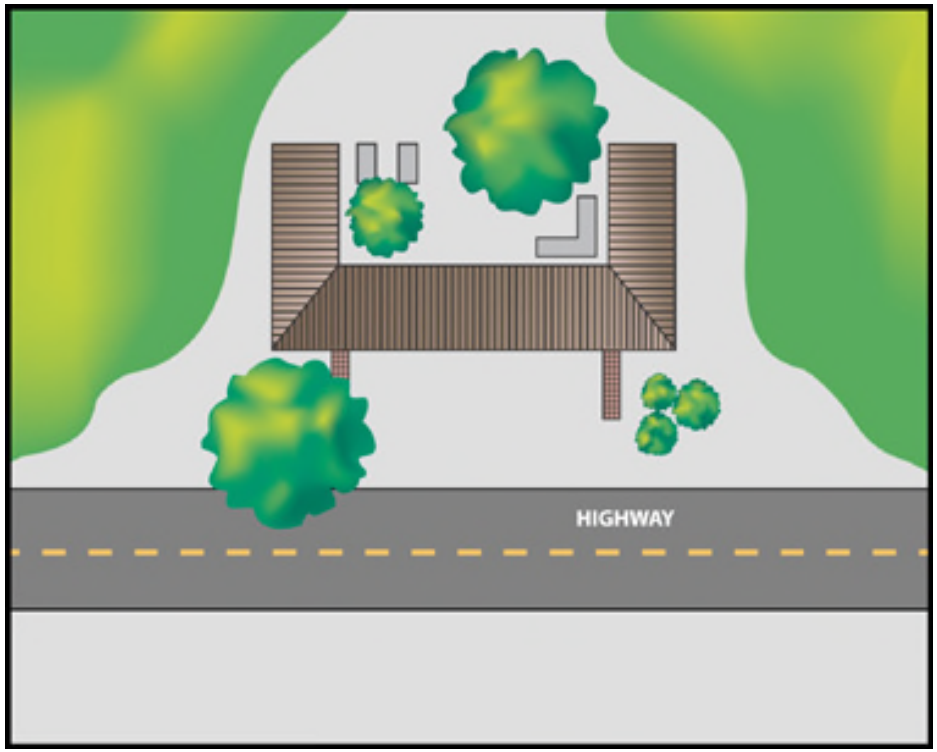
- 100 feet = 73 dB(A)
- 200 feet = 70 dB(A)
- 400 feet = 67 dB(A)

What did you get?

What would you get if this were a soft site area? **58 dB(A)**

What is shielding?

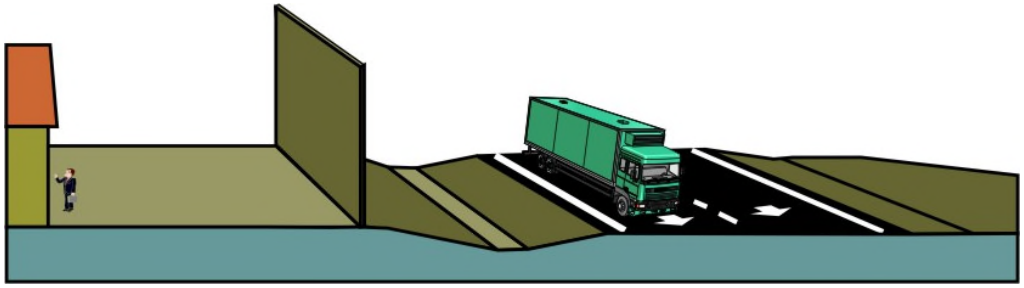
- Shielding is some large object that exists between the noise source and the receptor that can reduce overall noise levels.

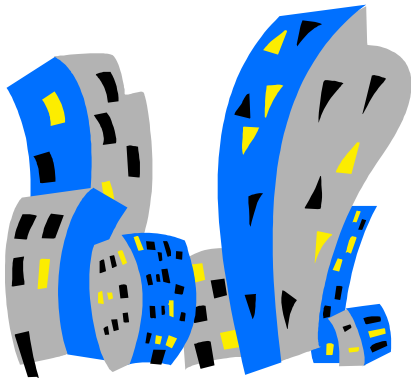


Source: FHWA

Examples of Shielding Include:

- Trees/Vegetation/Landscaping
- Buildings/Rows of Homes
- Noise Barriers

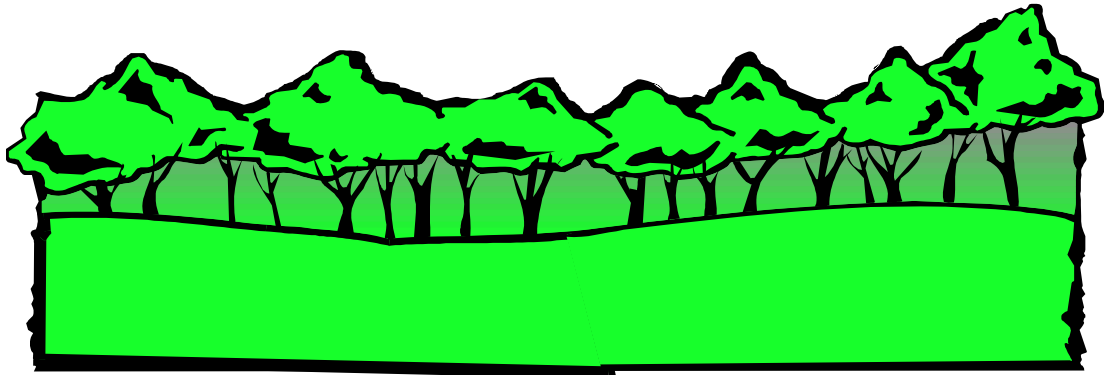




Vegetation and Traffic Noise

To reduce traffic noise, vegetation must be:

- 200 feet wide (between source and receptor)
- "Optically Dense" (You can't see through it)



Shielding From Buildings and Rows of Homes

- Provided by large buildings or rows of homes
- Will depend of the size of the structure(s) and the spacing between them

Shielding Can Also be Provided By Roadway Features, Such as:

- Elevated roadways on fill/embankment
- Elevated roadways on MSE/retaining walls
- The top edge of a depressed roadway (i.e., roadway in a "cut section"

Source: www.bigrbridge.com

Shielding from Building Envelope (Exterior to Interior Reduction)

- Will depend on the building construction and the amount of open/closed windows

Noise Reduction Provided by a Building

Building Type	Closed Window Condition	Noise Reduction Due to Building Structure
Light Frame	Ordinary Sash	
	Closed	20
	With Storm Windows	25
Masonry	Single Glazed	25
	Double Glazed	35

Noise Reduction Provided by a Building with Open Windows

Percent of Exterior Walls Having Open Windows	Approximate Noise Reduction
1%	17 dBA
2%	14 dBA
4%	11 dBA
8%	8 dBA
16%	5 dBA
32%	2 dBA
50%	0 dBA

Source: Fundamentals and Abatement of Highway Traffic Noise. 1973 BBN, Page I-35

Problem-Solving Time…….

If you have an exterior noise level of 76 dB(A) and 16% of the exterior walls have open windows, what would the noise level be inside that room?

71 dB(A)

If you have a home built of concrete block and stucco with closed single glazed windows covering 8% of the exterior wall, what is the noise level inside if the exterior noise level is 72 dB(A)?

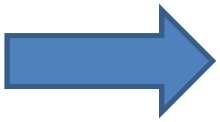
47 dB(A)

How about for the same scenario, but with the windows open?

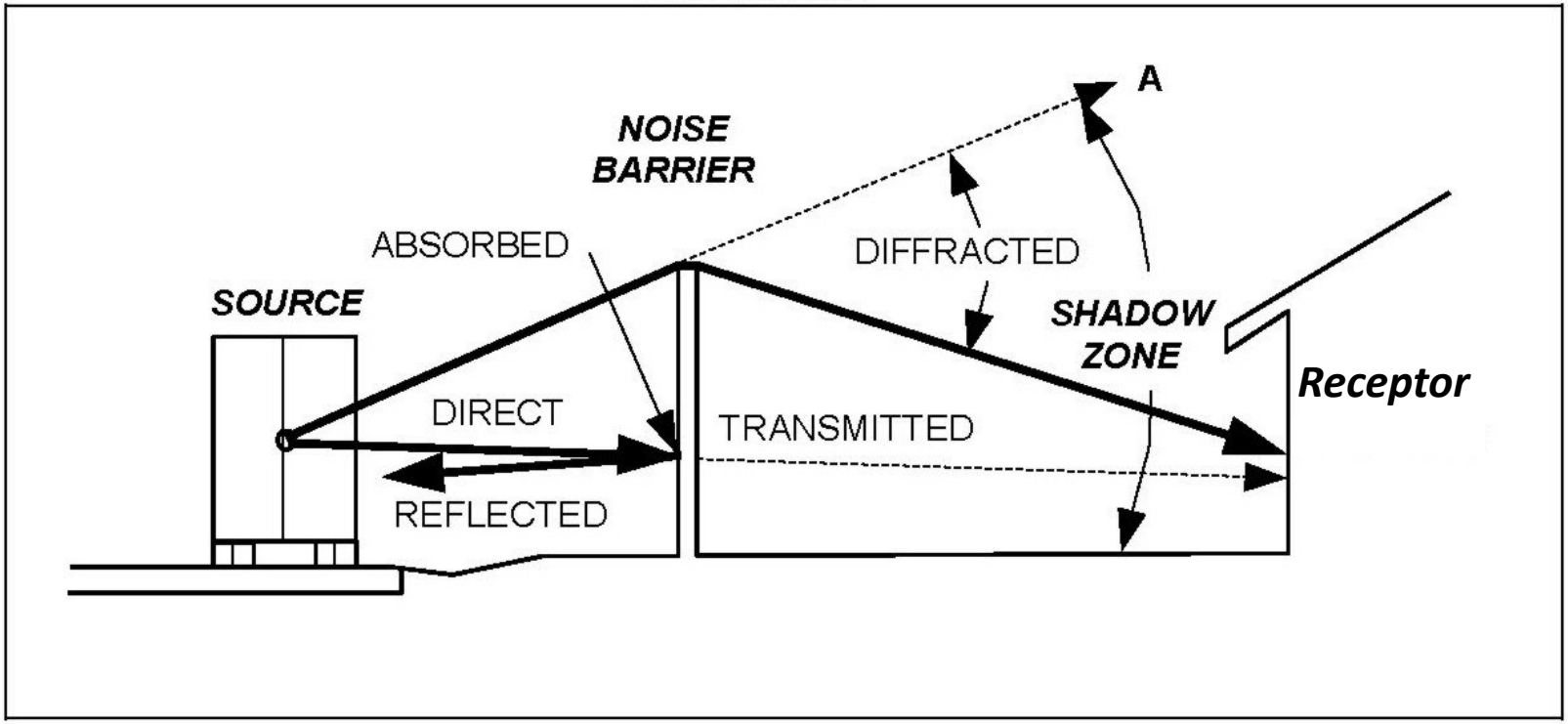
64 dB(A)

Noise Barrier Basics

How do they work?



By interrupting the direct noise path between the source and the receptor



Source: CALTRANS Technical Noise Supplement, 1998

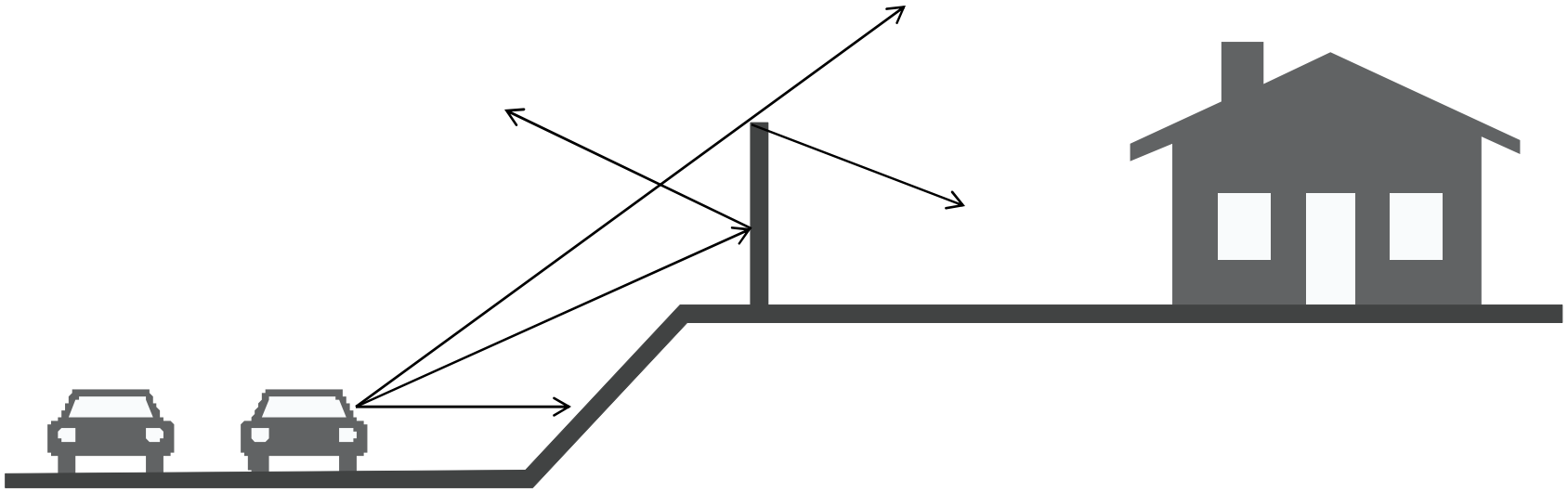
The result of all of the factors on the previous graphic, combined with any noise flanking around the barrier ends and the loss of excess ground attenuation, results in what is called “Insertion Loss” (IL) or the difference in noise levels from the “before barrier” and “after barrier” conditions.

Also referred to as “noise reduction”.

Noise Barrier Placement

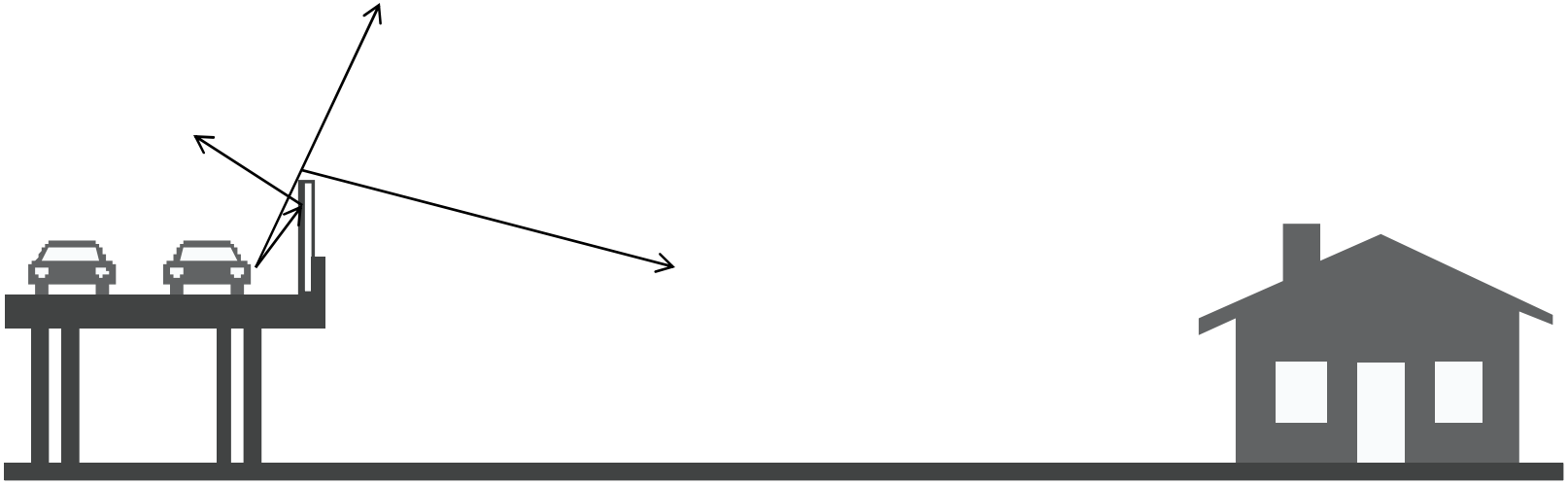
- As close to the receptor as possible
- If not, then as close to roadway as possible

If the roadway is depressed…



Noise barrier should be placed at the top of the cut slope, if possible

If roadway is elevated…



Noise barrier should be placed as close to the road as possible on elevated ground or structure.

Regardless of the location/elevation of the roadway, avoid placing the noise barrier in the middle if at all possible.

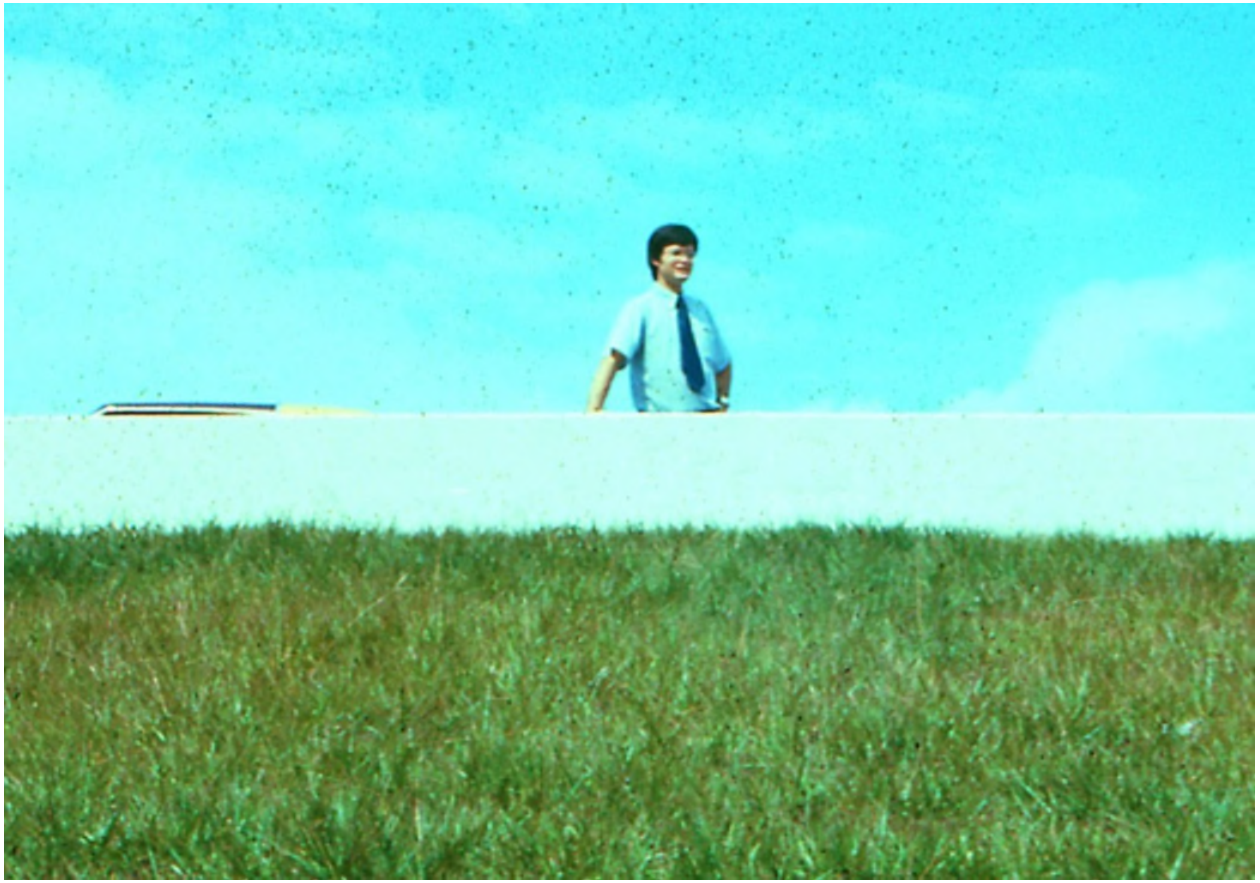
How Tall Does the Noise Barrier Have to Be?

- Many factors influence the height, but the general rule-of-thumb is…..

- The noise barrier has to at least break the line-of-sight to achieve a 5 dB(A) reduction, and

- For each 2 feet above the initial break in line-of-sight, you will achieve approximately an additional 1 dB(A)

Not an Effective Noise Barrier Design….



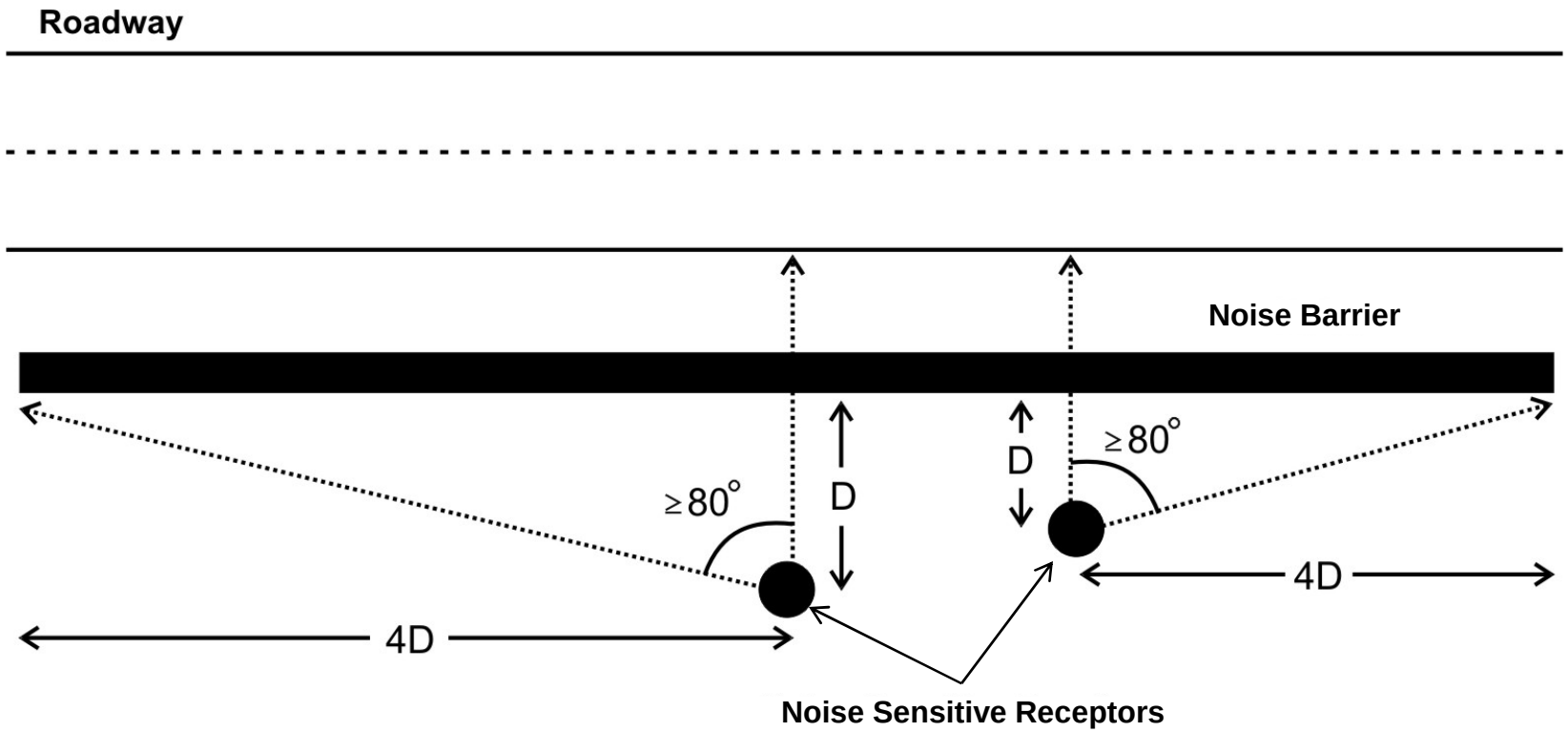
How Long Should the Noise Barrier Be?

As with the height, many factors will influence the length, but….

The general rule is that the barrier should extend “4D” beyond the last impacted receptor.

What is 4D??

Noise Barrier Length



SOURCE: FHWA Highway Noise Barrier Design Handbook, 2000

QUESTIONS?

Lesson Three

The PD&E Noise Study Process

Noise in the ETDM Process

- Early identification of potential issues and impacts
- Indicate if a noise study is required
- FHWA and FDOT are typical commenting agencies

etdm
Efficient Transportation Decision Making

PD&E vs. Design Noise Studies

- PD&E Noise Studies:
  - Fulfill requirements of 23 CFR Part 772 (and thus NEPA)
  - Are conceptual in nature
  - May include the screening of multiple viable alternatives
  - Evaluate existing, future no-build (design year) and future build (design year)
  - Do NOT make commitments to construct noise barriers (only commit to further evaluation in design)
  - Provide noise contour information to local officials

PD&E vs. Design Noise Studies

Design Phase Noise Studies:

- Fulfill commitments made during PD&E
- Only evaluate current roadway design
- Analyze future build condition only
- Use design-level detail (modeling is based on current roadway design and survey information)
- Make commitments to construct noise barriers

The Basic PD&E Noise Study Process

- Is a noise study required? → **23 CFR 772.7**
- Determine project limits → **23 CFR 772.5(8)**
- What land uses are present? → **23 CFR 772.11(d)(1)**
- Conduct measurements → **23 CFR 772.11**
- Predict traffic noise levels → **23 CFR 772.9**
- Evaluate abatement measures → **23 CFR 772.13**
- Documentation → **23 CFR 772.13(g)**
- Information for local officials → **23 CFR 772.17**

Alternatives Evaluation During PD&E

- 23 CFR 772.9(c)
- Use noise contours for screening only
- Conduct full detailed analysis for viable/preferred alternative(s)

Noise Monitoring

- Performed for one of two scenarios during PD&E
  - Determine existing traffic noise levels
  - Validate the computer model

Traffic Data

- "Traffic characteristics that yield the worst traffic noise impact for the design year shall be used" for modeling (23 CFR 772.9(d))

- Level of Service "C" or Demand volumes, whichever is less

- Vehicle Classification - Five vehicle types
  - Autos, Medium Trucks, Heavy Trucks, Buses, Motorcycles

Prediction of Traffic Noise Levels

- TNM, Version 2.5 or newer, to predict traffic noise levels
- Existing, Future No-Build, Future Build conditions
- All viable alternatives under detailed study
- Compare to NAC for each land use

A Traffic Noise Impact Occurs If:

- Future Build, Design Year traffic noise levels **approach**, meet or exceed the NAC for a given activity category
- What does **approach** mean?
    - Within 1 dB(A) of the NAC
- Future Build, Design Year traffic noise levels increase substantially (15 dB(A) or more) when compared to existing levels

Noise Abatement Criteria (NAC)

Activity Category	Activity Leq(h)		Evaluation Location	Activity Description
	FHWA	FDOT		
A	57	56	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67	66	Exterior	Residential
C	67	66	Exterior	Active sports areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreational areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52	51	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E	72	71	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	--	--	--	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	--	--	--	Undeveloped lands that are not permitted.

NAC Activity Category "A"

Activity Category	Activity Leq(h)		Evaluation Location	Activity Description
	FHWA	FDOT		
A	57	56	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.

- Only used on case-by-case basis
- Justification and approval from before proceeding (FHWA approval on Federal projects, state approval for state projects)
- Example: "Tomb of the Unknown Soldier"

NAC Activity Category "B"

Activity Category	Activity Leq(h)		Evaluation Location	Activity Description
	FHWA	FDOT		
B	67	66	Exterior	Residential

- Includes single family (SF) and multi-family (MF) residences
- Each dwelling unit is considered a noise sensitive site
- May be located above ground level

NAC Activity Category "C"

Activity Category	Activity Leq(h)		Evaluation Location	Activity Description
	FHWA	FDOT		
C	67	66	Exterior	Active sports areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreational areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.

- Exterior only for these land uses
- "Special Use Methodology" to evaluate abatement reasonableness for active use areas (FL-ER-65-97)
- Section 4(f) sites will only apply to Federal projects

NAC Activity Category "D"

Activity Category	Activity Leq(h)		Evaluation Location	Activity Description
	FHWA	FDOT		
D	52	51	**Interior**	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.

- Only activity with Interior noise abatement criteria
- No exterior use areas
- Apply building reduction factor or conduct measurements

Noise Reduction Provided by a Building

Building Type	Closed Window Condition	Noise Reduction Due to Building Structure
Light Frame	Ordinary Sash	
	Closed	20
	With Storm Windows	25
Masonry	Single Glazed	25
	Double Glazed	35

Noise Reduction Provided by a Building with Open Windows

Percent of Exterior Walls Having Open Windows	Approximate Noise Reduction
1%	17 dBA
2%	14 dBA
4%	11 dBA
8%	8 dBA
16%	5 dBA
32%	2 dBA
50%	0 dBA

Source: Fundamentals and Abatement of Highway Traffic Noise. 1973 BBN, Page I-35

NAC Activity Category "E"

Activity Category	Activity Leq(h)		Evaluation Location	Activity Description
	FHWA	FDOT		
E	72	71	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.

- Must be frequent exterior use area
- Hotel/Motel pools included in Category E
- Use "Special Land Use" Methodology

NAC Activity Category "F"

Activity Category	Activity Leq(h)		Evaluation Location	Activity Description
	FHWA	FDOT		
F	--	--	--	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.

- Land uses less sensitive to traffic noise
- No abatement criteria = No analysis required

NAC Activity Category "G"

Activity Category	Activity Leq(h) [1]		Evaluation Location	Activity Description
	FHWA	FDOT		
G	--	--	--	Undeveloped lands that are not **PERMITTED**

- Permitted: A definite commitment to develop land with an approved specific design of land use activities as evidenced by the issuance of a building permit.
- Date of Public Knowledge (DPK): Date of approval of CE/FONSI/ROD

The Correct Activity Category Is…..?

Use / Activity	Activity Category						
	A	B	C	D	E	F	G
Cemetery							
Church with no outdoor use							
High school football field							
Duplex Residences							
Storage warehouse							
Pool at a hotel							
Single-family residence							
Outdoor seating at your favorite bar							
Monastery							

The Correct Activity Category Is…..?

Use / Activity	Activity Category						
	A	B	C	D	E	F	G
Cemetery			X				
Church with no outdoor use							
High school football field							
Duplex Residences							
Storage warehouse							
Pool at a hotel							
Single-family residence							
Outdoor seating at your favorite bar							
Monastery							

The Correct Activity Category Is…..?

Use / Activity	Activity Category						
	A	B	C	D	E	F	G
Cemetery			X				
Church with no outdoor use				X			
High school football field							
Duplex Residences							
Storage warehouse							
Pool at a hotel							
Single-family residence							
Outdoor seating at your favorite bar							
Monastery							

The Correct Activity Category Is…..?

Use / Activity	Activity Category						
	A	B	C	D	E	F	G
Cemetery			X				
Church with no outdoor use				X			
High school football field			X				
Duplex Residences							
Storage warehouse							
Pool at a hotel							
Single-family residence							
Outdoor seating at your favorite bar							
Monastery							

The Correct Activity Category Is…..?

Use / Activity	Activity Category						
	A	B	C	D	E	F	G
Cemetery			X				
Church with no outdoor use				X			
High school football field			X				
Duplex Residences		X					
Storage warehouse							
Pool at a hotel							
Single-family residence							
Outdoor seating at your favorite bar							
Monastery							

The Correct Activity Category Is…..?

Use / Activity	Activity Category						
	A	B	C	D	E	F	G
Cemetery			X				
Church with no outdoor use				X			
High school football field			X				
Duplex Residences		X					
Storage warehouse						X	
Pool at a hotel							
Single-family residence							
Outdoor seating at your favorite bar							
Monastery							

The Correct Activity Category Is…..?

Use / Activity	Activity Category						
	A	B	C	D	E	F	G
Cemetery			X				
Church with no outdoor use				X			
High school football field			X				
Duplex Residences		X					
Storage warehouse						X	
Pool at a hotel					X		
Single-family residence							
Outdoor seating at your favorite bar							
Monastery							

The Correct Activity Category Is…..?

Use / Activity	Activity Category						
	A	B	C	D	E	F	G
Cemetery			X				
Church with no outdoor use				X			
High school football field			X				
Duplex Residences		X					
Storage warehouse						X	
Pool at a hotel					X		
Single-family residence		X					
Outdoor seating at your favorite bar							
Monastery							

The Correct Activity Category Is…..?

Use / Activity	Activity Category						
	A	B	C	D	E	F	G
Cemetery			X				
Church with no outdoor use				X			
High school football field			X				
Duplex Residences		X					
Storage warehouse						X	
Pool at a hotel					X		
Single-family residence		X					
Outdoor seating at your favorite bar					X		
Monastery							

The Correct Activity Category Is…..?

Use / Activity	Activity Category						
	A	B	C	D	E	F	G
Cemetery			X				
Church with no outdoor use				X			
High school football field			X				
Duplex Residences		X					
Storage warehouse						X	
Pool at a hotel					X		
Single-family residence		X					
Outdoor seating at your favorite bar					X		
Monastery	X						

Traffic Noise Impacts

- To be considered impacted: future build, design year traffic noise levels must either:

  - Approach, Meet or Exceed the NAC
  - ➢ **Approach**: Within 1 dB(A)

  - Increase substantially from existing levels
  - ➢ FDOT defines "**substantial increase**" as 15 dB(A) or greater

Traffic Noise Impacts

- TNM predicts sound levels to 1/10th dB(A), no rounding
- For a residence, 65.9 dB(A) is NOT impacted, 66.0 dB(A) IS impacted
- Likewise, an increase of 14.9 dB(A) compared to existing is not “substantial”

Noise Abatement Measures

- Noise barriers – most popular and only form required for consideration by 23 CFR 772
- Can also consider:
  - Traffic management
  - Alternative roadway alignments
  - Property acquisition for buffer zones
  - Insulation of Activity Category D uses

Feasibility and Reasonableness

Abatement measures have to be reasonable and feasible!

- **Feasibility:** The combination of acoustical and engineering factors considered in the evaluation of a noise abatement measure. (23 CFR 772.5 and 772.13(d)(1))

- **Reasonableness:** The combination of social, economic and environmental factors considered in the evaluation of a noise abatement measure. (23 CFR 772.5 and 772.13(d)(2))

Feasibility and Reasonableness During PD&E

- Only cost and noise reduction requirements considered during PD&E

- To be advanced for consideration during design phase, a noise barrier MUST:
  - Achieve Noise Reduction Design Goal
  - Benefit at least two impacted receptors
  - Cost $\leq$ $42,000 per benefited receptor

- Other considerations can be noted, but further evaluation will occur during design

Feasibility

- Noise Reduction Requirements:
  - At least 5 dB(A) reduction at a minimum of two (2) impacted receptors
- Engineering Considerations:
  - Can the noise barrier be constructed as designed?
  - Topography, safety, drainage, utilities, maintenance, ROW, access requirements

Reasonableness

1. Noise Reduction Design Goal (NRDG): At least one (1) benefited receptor must achieve a 7 dB(A) reduction

2. Cost effectiveness: $30/ft^2 and $42,000/benefited receptor

3. Consideration of viewpoints of benefited property owners and residents

➢ All the above factors must be achieved to meet reasonableness requirements!

"Special Land Use" Methodology

- For determination of reasonableness of abatement at Activity Category C, D and E locations
- Use when you have "areas" of impact, rather than discrete locations
- Evaluates the amount of impacted area that may be benefited, and the amount of time people might spend in impacted and benefited area
  - Translates to a cost per person-hour per ft^2 of barrier

Noise Abatement Commitments During PD&E

- FDOT does NOT commit to noise barrier construction during PD&E!
- Commit to detailed reevaluation during design phase
- “Statement of Likelihood” (23 CFR 772.13(g)(3))

Public Involvement During PD&E Studies

- *Most* PD&E Studies for FDOT include at least one "Alternatives Public Workshop" and a Public Hearing
- Preliminary impact information, typically via "Noise Contours" is provided at the public workshops
- Results of detailed analysis and abatement measures recommended for further consideration provided at Public Hearing
- Other activities if warranted by project

Construction Noise and Vibration

- Identify sites that may be potentially impacted
  - Residences
  - Schools
  - TV/Radio facilities
  - Medical/Vision facilities
  - Laboratories

- Document in Noise Study Report (NSR) and environmental document for project

TABLE 17.3
Construction Noise and Vibration Sensitive Sites
(a partial listing of potential sites)

Noise	Vibration
Eye Centers/Clinics Medical Centers Hospitals Geriatric Centers Sound Recording Studios TV/Radio Stations Residences Technical Laboratories Hearing Testing Centers Theaters Schools Motels/Hotels Funeral Homes Libraries Meditation Centers Churches/Shrines Parks Day Care Centers Outdoor Theaters	Eye Centers/Clinics Medical Centers Hospitals Geriatric Centers Sound Recording Studios TV/Radio Stations Residences Technical Laboratories Antiques Shops Museums Historic Buildings
Note: This list is not meant to be all inclusive or exclusive, but rather an indication of the type of sites likely to be sensitive to construction noise and/or vibration.	
Source: FDOT Noise and Vibration Task Team; August 17, 1999.	

Noise Contours and Local Coordination

- PD&E NSRs shall include an estimation of the distance to impact criteria for each NAC

- After Location and Design Concept Acceptance (LDCA) or approval of State Environmental Impact Report (SEIR), noise contour info shall be provided to local government officials whose jurisdiction the project is located in (typically at the County level)

Questions?

Lesson Four

The Design Phase Noise Study Process

Design Phase Noise Studies:

- Fulfill commitments made during PD&E
- Only evaluate preferred alternative (proposed design)
- Evaluate future build condition only
- Use design-level detail (modeling is based on proposed roadway design and survey information)
- Make commitments to construct noise barriers

Design Phase Noise Studies

- Five step review process:

1. PD&E Study Review
2. Land Use/Field Review
3. Building Permit/Date of Public Knowledge (DPK) Review
4. Review of federal/state laws and regulations
5. Review of proposed roadway design

If Changes are Identified:

- For roadway design changes, follow “Type I” project definitions
    - Significant horizontal or vertical alteration
    - Additional capacity
    - Other improvements not evaluated during PD&E
- May require reevaluation of entire project corridor for impacts and abatement potential

If Changes are Identified (Continued):

- Reevaluate for design year, “build” condition only
- Determine if PD&E traffic data still current

If PD&E Study Commits to Noise Barrier Reevaluation:

- Predict design year traffic noise levels for adjacent community/communities using design-level detail
- Reevaluate noise barrier feasibility and reasonableness based on design analysis
- If noise reduction and cost requirements are confirmed, proceed with engineering feasibility review

Noise Barrier Evaluations in the Design Phase

- Phase I (30%) Plans
  - Remember to review subsequent plan sets for changes!
- Roadway elevations obtained from cross sections or profiles
- Bottom (ground) elevations for evaluated noise barriers obtained from roadway cross sections
- The lack of availability of this information during PD&E is why FDOT does not commit to noise barrier construction at that time

Noise Barrier Evaluations in the Design Phase

- The same noise reduction and cost criteria apply:
  - 5 dB(A) reduction to be considered benefited
    - For at least 2 impacted receptors
  - 7 dB(A) NRDG to at least one benefited receptor
  - $42,000/benefited receptor @ $30/ft^2

Noise Barrier Recommendations

- Barrier height and length combination that provides the highest # of impacted receptors a reduction of $\geq$ 5 dB(A) as well as the NRDG while at or below the cost reasonableness criteria

- This height/length combination is moved forward for "engineering feasibility review" prior to initiating public involvement

Noise Barrier Engineering Feasibility Review

- Conduct prior to noise barrier-specific public involvement
- Ensure noise barrier can be constructed as planned
- Review items contained in Sections 17.6.1.2 through 17.6.1.8 of Chapter 17 of the PD&E Manual
- **Bottom line**: The last thing you want to do is go to the public with a noise barrier you are not 100% certain you can construct!

Noise Barrier Engineering Feasibility Reviews

- Can the barrier be constructed as planned using routine materials and methods?
- Additional costs **SOLELY** to accommodate the noise barrier are to be included in the overall cost and cost per benefitted receptor calculations

Noise Barrier Engineering Feasibility Review Considerations:

- Safety
- Access
- Right-of-Way (ROW)
- Maintenance
- Drainage
- Utilities (Overhead and sub-surface)

Noise Barrier Engineering Feasibility Reviews

Consideration: **Safety**

- Height limitations:
  - Ground mounted at ROW: 22’ max
  - Ground mounted at shoulder (on embankment only): 14’
  - On bridge/wall structures: 8’
- Crash test requirements if inside clear zone
- Sight distance requirements when noise barrier ends approach intersections / cross streets

Noise Barrier Engineering Feasibility Reviews

Consideration: **Safety**

Noise Barrier Engineering Feasibility Reviews

Consideration: **Access**

- Primarily for non-limited access facilities (arterials)
- Noise Barrier cannot block ingress/egress to properties adjacent to noise barrier
- Can be avoided by openings in evaluated barrier for driveways, cross streets, etc.
- Same consideration applies for sidewalks and other normal routes of travel

Noise Barrier Engineering Feasibility Reviews

Consideration: **Right-of-Way Factors**

- Are there adequate ROW needs for construction and maintenance of the noise barrier?

Noise Barrier Engineering Feasibility Reviews

Consideration: **Maintenance Factors**

- Maintenance crews must have adequate room on both sides of barrier for maintenance personnel and equipment

- District 1 now uses 12’ inside ROW as standard location to allow adequate room for maintenance. Other Districts use a distance of approximately 5’.

Noise Barrier Engineering Feasibility Reviews

Consideration: **Drainage Factors**

- Important consideration since many drainage activities occur at/near the ROW (swales, etc.)
- This item should be reviewed in detail by the drainage engineer for the project

Noise Barrier Engineering Feasibility Reviews

Consideration: **Drainage Factors**

Noise Barrier Engineering Feasibility Reviews

Consideration: **Drainage Factors**

Noise Barrier Engineering Feasibility Reviews

Consideration: **Utility Factors**

- Most common type of conflict with noise barriers
- Includes both above and below-ground utilities
- If utility is permitted within FDOT ROW, they must relocate to accommodate noise barrier at their own cost
- If utility is outside FDOT ROW, relocation costs are incurred by FDOT and included in noise barrier cost reasonableness

Noise Barrier Engineering Feasibility Reviews

Consideration: **Utility Factors – Overhead Utilities**

Issues:

- Short term construction equipment clearances
- Long term wall clearances
- Can electric line be relocated or shut down?

Noise Barrier Engineering Feasibility Reviews

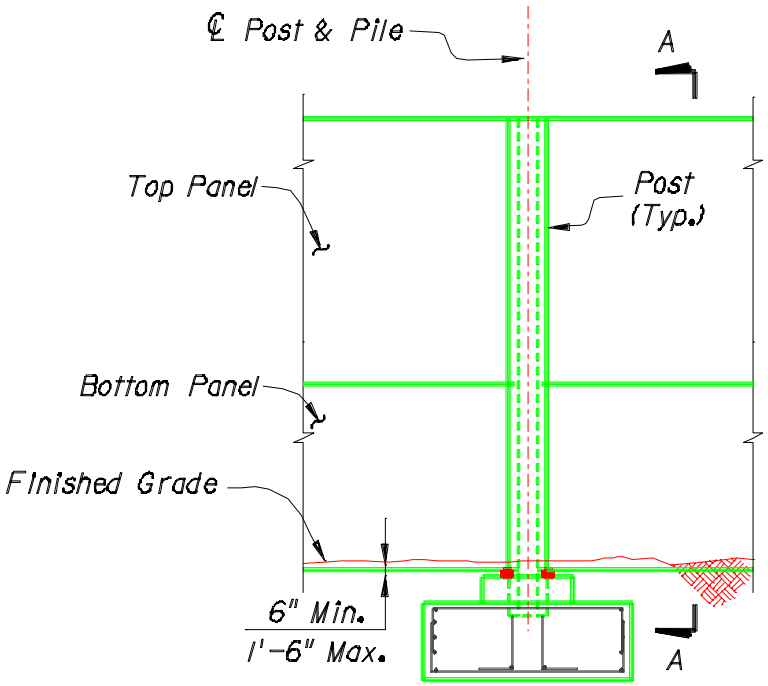
Consideration: **Utility Factors – Overhead Utilities**

Possible Solution: Low overhead equipment to drill post hole

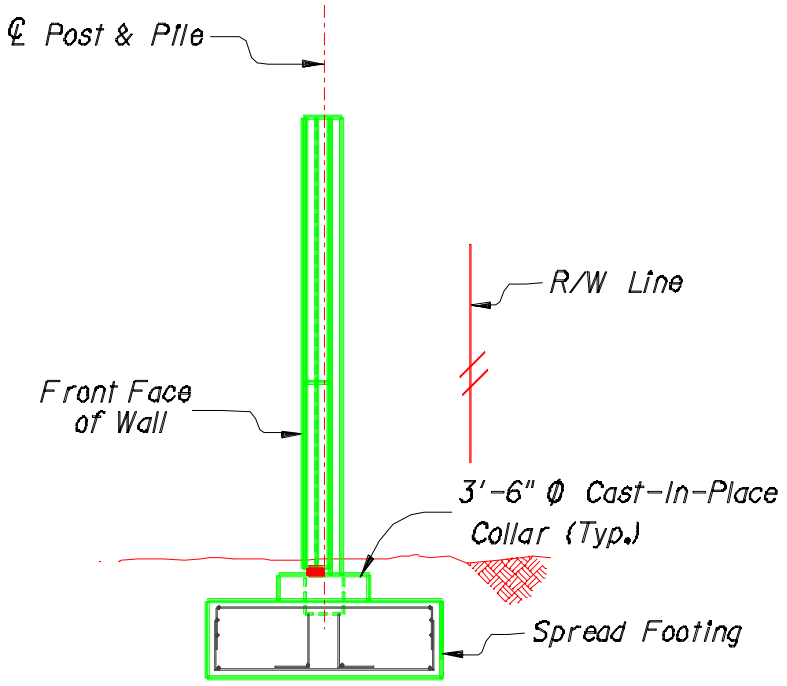
Noise Barrier Engineering Feasibility Reviews

Consideration: **Utility Factors – Overhead Utilities**

- If auger-cast post holes are not possible, a spread footing foundation can be used



ELEVATION VIEW



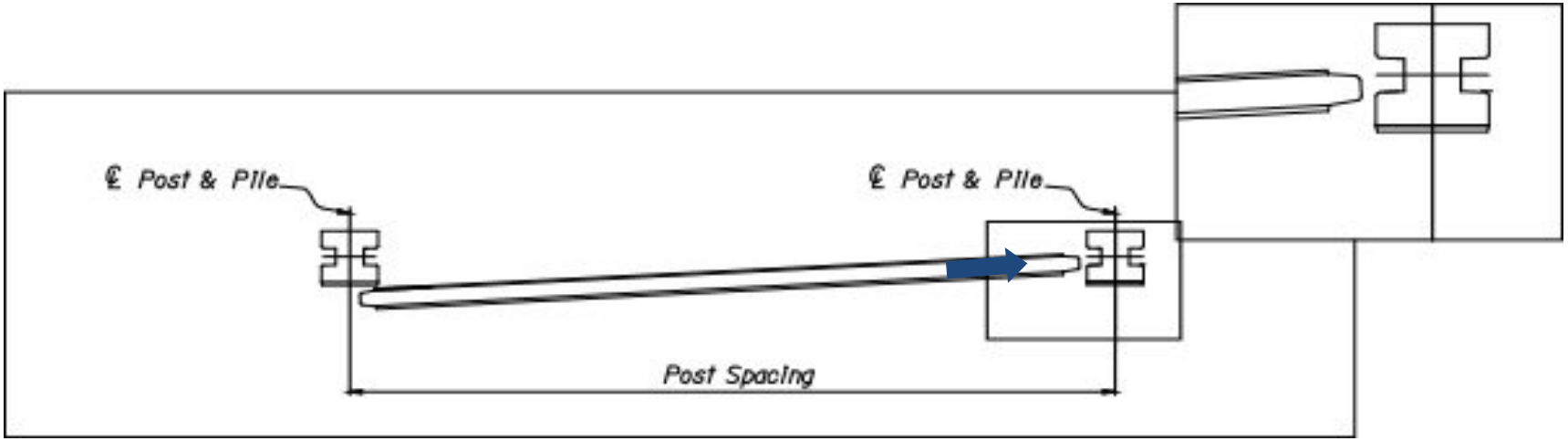
SECTION A-A

Noise Barrier Engineering Feasibility Reviews

Consideration: **Utility Factors – Overhead Utilities**

- Noise barrier panels can be side-loaded to avoid overhead conflicts

(See Design Standard Index 5200 Sheets 4 & 5)



NOISE BARRIER ENGINEERING REVIEW FORM

FPID: 201032-4-32-01 and 201277-2-32-01
I-75 at University Parkway Interchange Design, Sarasota and Manatee Counties

Noise Barrier 1: Gateway Lakes Apartments, San Palermo Townhomes, and Isolated Residences North of San Palermo Townhomes (Ultimate Design)

Reviewers Name/Department: _____

Review Date: _____

Location:	Ten (10) feet inside the Limited Access (LA) Right of Way (ROW) for I-75. Begin at STA. 345+00.00L and end at STA. 110+00.00L.
Length:	5,515 feet
Height:	22 feet above finished grade
Estimated Cost:	$3,639,900
Preliminary Concept Design:	Michael Mulbarger – ESA
Design/Constructability Issues:	
Drainage Issues:	
Utility Issues:	
Safety Issues:	
Maintenance Issues:	
ROW Acquisition Issues:	
Legal Issues:	
Are any of the above issues severe enough so that a noise barrier cannot be constructed at this location? If so, please explain in detail.	
Barrier Aesthetics:	Aesthetics for the noise wall will be solicited from Sarasota County (roadway side) and the adjacent property owners (residential side) during the upcoming public involvement phase.

Please return to Jeffrey James (email: JeffreyW.James@dot.state.fl.us or MS 1-40) **no later than Monday, May 5, 2014.**

Noise Barrier Engineering Feasibility Reviews

- The earlier potential conflicts are identified, the better
- Chances are, the issue has been encountered on another project
- All issues must be resolved before proceeding with design-phase public involvement
- Resolution of some issues may result in modifications to noise barrier length, height and existence

Design Noise Study Report Addendum (NSRA)

- Follow review process in documentation
  - PD&E study review
  - Land use / field review
  - Building permit / DPK review
  - Review of Federal/State regulations
  - Review of current roadway design

Design Noise Study Report Addendum (NSRA)

- Document engineering feasibility reviews and include support materials in an appendix
- Important to document public involvement activities, especially those related to proposed noise abatement
  - Changes to barrier length based on owner/resident desires
- Provide examples of noise barrier survey materials in an appendix, including certified mail receipts

Plan Preparation Manual (PPM) Chapter 32

- Provides details on noise barrier requirements:
  - Noise abatement criteria
  - Noise barrier height restrictions
  - Documentation
  - Commitments
  - Plans preparation items:
    - Control drawings
    - Geotechnical
    - Design Standards
    - Project Requirements

Questions?

Lesson Five
Public Involvement

Public Involvement During PD&E

- Typically consists of 1 or 2 workshops and a hearing

- "Alternatives Workshop"
  - Seek public input on proposed alternatives
  - Noise contours only, no detailed analysis
  - No abatement evaluation

Public Involvement During PD&E

- Public Hearing
  - Detailed analysis completed
  - Draft Noise Study Report Available
  - Location of potentially feasible and cost reasonable abatement

- NSR not finalized until after all public involvement complete

Noise Barrier-Specific Public Involvement During Design

- Do not begin until engineering review complete!

- 23 CFR 772.13(d)(2) – Noise Abatement Reasonableness:
  "…… Consider viewpoints of property owners and residents of benefited receptors….. shall solicit viewpoints…..and obtain enough responses to document a decision regarding abatement."

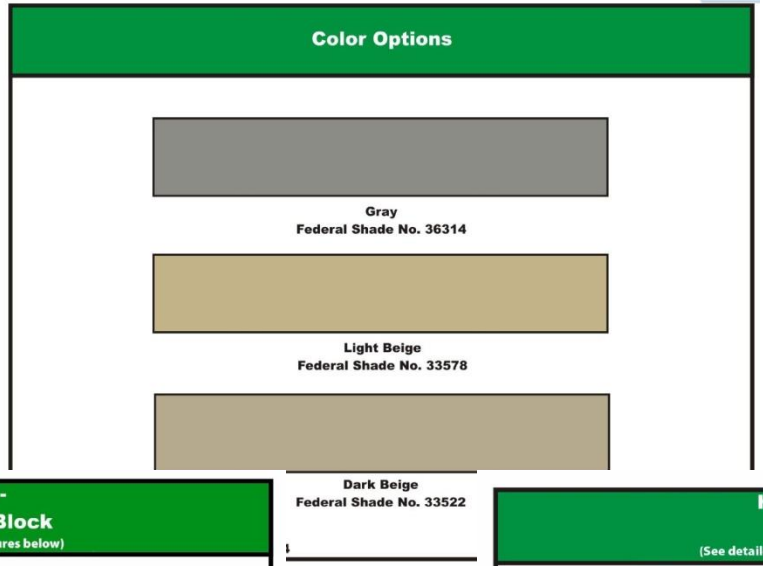
Noise Barrier-Specific Public Involvement During Design

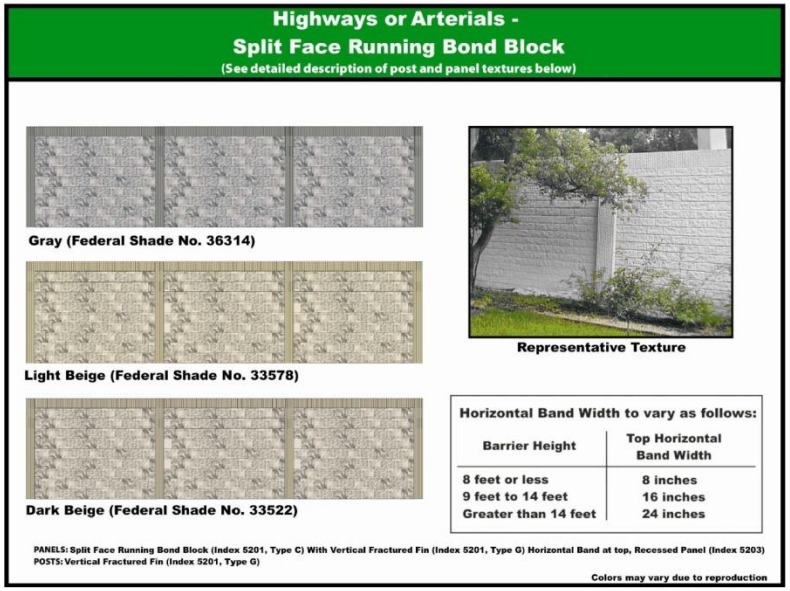
- State highway agency shall define, and receive FHWA approval for, the number of receptors needed to constitute a decision (23 CFR 772.13(d)(2))
- FDOT: decision based on a majority of those that *respond* to survey
- Survey methods can include workshops, mailed surveys, door-to-door visits and telephone surveys

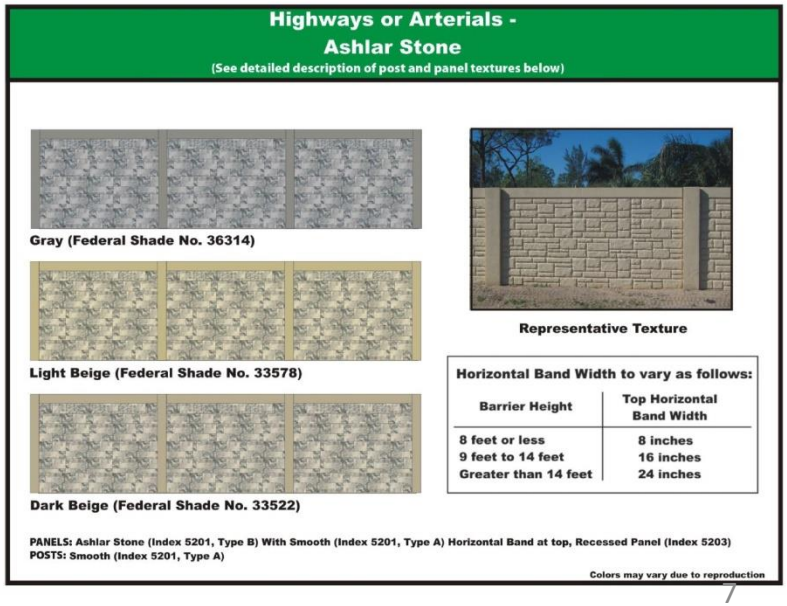
Noise Barrier Surveys

- Typically consist of a “Notification Letter” and the survey package
- Survey package may contain:
  - Cover letter
  - Map/aerial showing proposed barrier location
  - Noise Barrier Information Sheet
  - Available aesthetic options
  - Survey form
  - Addressed/stamped return envelope
  - Sent via Certified Mail

Noise Barrier Surveys – Aesthetic Options







Noise Barrier Surveys and HOA's

- Homeowner's Association (HOA)
- May own "common land" adjacent to ROW (noise sensitive receptors are not present)
- Solicit their input via survey, but HOA's cannot determine the outcome of noise barrier

Noise Barrier Surveys

- Property owners/residents select color and texture for residential side of noise barrier
- Some districts allow the county to select color/texture for roadway side of noise barrier
- Send follow-up letter to all surveyed owners/residents with outcome of survey process

Outdoor Advertising Conflicts (FS 479.25)

- If a proposed noise barrier will block the visibility of a legally permitted, conforming and erected outdoor advertising sign:

  - Increase height of sign, notify local government/jurisdiction
  - If increasing height violates local ordinance/land development code, FDOT shall inform impacted and benefited property owners via written survey

  - If the majority of impacted property owners vote for noise barrier construction:
    - Allow increase in height of sign (even if in violation of local ordinance)
    - Allow sign to be relocated/reconstructed at another location if sign owner agrees
    - Pay fair market value of sign and its associated interest in real property
    - FDOT must hold public hearing

Noise Barrier Workshops

- Can be used to gauge public support/opposition to proposed abatement
- Also used for informational purposes after survey package sent
- Typically held separate from project-wide workshops

QUESTIONS?

Lesson Six

The Role of the Design Team in Noise Abatement

- The goal of the design team is to ensure that the wishes of the public and the Department regarding noise abatement are met and that the finished product achieves the intended noise reduction while being constructible, aesthetically pleasing, and can be maintained using standard maintenance practices.

Design Project Manager

- Manage the project and the team
- Provide coordination between team members
- Assure that information is available and shared
- Coordinate public involvement activities related to noise barriers
- Conduct or have conducted an engineering feasibility review of the proposed noise barrier(s)

Roadway Design Engineer

- Utility conflict resolution
- Review safety features of the noise barrier that may be needed (if inside the clear zone)
- Coordinate with the Landscape Architect, Drainage Engineer and Utilities Engineer
- Prepare the noise barrier control drawings
- Update the Traffic Control Plans and the Utility Relocation Plans

Structures Engineer

- Coordinate noise barrier plan development
- Develop plan notes
- Develop required specifications
- Develop structural details
- Ensure that all commitments made regarding the size, location, and aesthetics of the noise barrier are incorporated into the design

Utility Engineer

- Review wall control plans and roadway cross sections for potential impact on utilities above and below ground

- Coordinate with impacted utilities to ensure constructability of the noise barrier and determine utility impacts

Geotechnical Engineer

- Obtain soil borings
- Review noise barrier plans for potential impact of soils on the structural design of the noise barrier
- Coordinate with structural design engineer to ensure constructability of the noise barrier

Drainage Engineer

- Provide input regarding the number and location of drainage holes and grading details
- Review wall control plans for potential impacts to drainage structures, drainage patterns, or pond locations
- Suggest alternatives when conflicts occur
- Review drainage accommodations designed into the noise barrier

Noise Analyst / District Noise Specialist

- Assess noise abatement options and evaluate changes
- Provide design team with recommended noise barrier dimensions and location
- Provide technical guidance to the design team regarding material options
- Review impacts of proposed noise barrier on utilities, safety, maintenance, construction, drainage, right of way, and offer design options to overcome these impacts

Noise Analyst / District Noise Specialist (Continued)

- Serve as the point of contact for noise-related questions from the design team and others
- Prepare noise information for public involvement activities as well as the noise barrier survey items
- Prepare the Noise Study Report Addendum
- Prepare follow-up information to impacted property owners regarding the status of the proposed noise abatement
- Coordinate with local officials regarding placement and aesthetics of the noise barrier

Public Involvement Specialist

- Coordinate public involvement meetings
- Provide information regarding noise abatement to inquiring persons

Others that may be Involved

- District Construction Engineer regarding constructability issues
- District Maintenance Engineer regarding maintenance issues such as access, graffiti, vegetation removal, and repainting
- District Right of Way Specialist regarding potential easements (construction or maintenance), conflicts with legally permitted outdoor advertising signs, and potential property takings

Others that may be Involved

- District Environmental Administrator regarding overall impact of noise on the project area, coordinates with the Design Project Manager regarding go/no go decisions, reviews reports and survey information, participates in the public involvement activities, meets with local officials, and oversees the internal engineering reviews

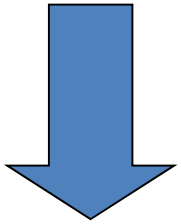
- District Landscape Architect will review the impact of the proposed noise barrier on existing vegetation, review plans to offer re-vegetation schemes, assess noise barrier aesthetics, and coordinate planting drawings

QUESTIONS?

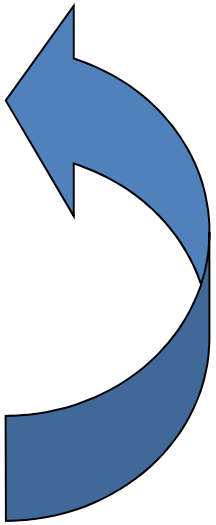
Lesson Seven
Designing a Noise Barrier

Noise Barrier Design Phase Objective

- Noise Study Report



- Contract Documents
  - Structure Plans
  - Noise Barrier Control Drawings
  - Traffic Control & Roadway Plans as Necessary
  - Specifications



Reassessment and Coordination with District Noise Specialist as Required

Noise Barrier Types

- **Ground Mounted**
  - Standard Precast Noise Barrier
  - Non-Standard Precast Noise Barrier
  - Cast-In-Place Concrete Noise Barrier
  - Masonry Noise Barrier on Spread Footing (Non-Standard)

- **Shoulder Mounted**
  - 8’ Bridge Mounted Noise Barrier
  - 8’ Retaining Wall Mounted Noise Barrier
  - 8’ and 14’ Shoulder Mounted Noise Barrier (Embankment)

7 Step Noise Barrier Design Process

1. Review the noise study report addendum
2. Create preliminary noise barrier control drawings

→ Preliminary Location

3. Locate the noise barrier in the field and determine conflicts with overhead/ underground utilities, drainage structures

→ Determine Constraints

4. Select noise barrier types
5. Finalize noise barrier control drawings

→ Based on Constraints Finalize Location and Type

6. Begin the geotechnical investigation
7. Design noise barrier

→ Provide Structural Design

7 Step Noise Barrier Design Process

➢ Step 1: Review Noise Study Report Addendum (NSRA)

- Noise barrier location
- Noise barrier height/length
- Special notes related to constructability, public input, etc.

7 Step Noise Barrier Design Process

➢ Step 2: Create preliminary control drawings

- Limits of noise barrier
- Plan and profile view depicting horizontal and vertical location

7 Step Noise Barrier Design Process

- **Step 3: Determine conflicts with noise barrier**

7 Step Noise Barrier Design Process

➢ Step 4: Select noise barrier type to be designed

- Ground Mounted
  - Standard precast noise barrier
  - Non-standard precast noise barrier
  - Cast-in-place concrete noise barrier
  - Masonry noise barrier on spread footing

- Shoulder Mounted
  - 8’ crash tested bridge noise barrier
  - 8’ retaining wall mounted noise barrier
  - 8’ and 14’ shoulder mounted noise barrier

7 Step Noise Barrier Design Process

➢ Step 5: Finalize Control Drawings – Plan View

- Noise barrier alignment and location
- Begin/End stations and offsets, including offset definition (typically from baseline to front face of barrier)
- Step locations
- Drainage holes - type and station locations
- Adjacent overhead or in-ground utilities
- Limits of sod or seeding/topsoil application
- If removal of organic soils is necessary, show limits of removal and improvements, as well as methods and method of payment

7 Step Noise Barrier Design Process

➢ Step 5: Finalize control drawings – Elevation View

- Begin/End wall stations
- Ground line elevations
- Top of noise barrier elevations
- Bottom of noise barrier elevations and post length
- Drainage holes, including type
- Adjacent overhead or in-ground utilities
- Locations and names of noise barrier graphics (if any)
- Limits of anti-graffiti coating (if any)

7 Step Noise Barrier Design Process

➢ Step 5: Finalize Control Drawings – Data Tables

PROJECT REQUIREMENTS								Table Date 1-01-14
WALL NO. (1)	REQUIRED: (YES/NO)			REQUIRED TEXTURES:				PANEL TYPE (FLUSH/ RECESSED/ EITHER)
	GRAPHICS (1)	COLORED COATINGS (2)	PRECAST POST CAP (3)	PANELS:		POSTS:		
				FRONT FACE	BACK FACE	FRONT FACE	BACK FACE	

(1) See Control Drawings.
(2) Coat all exposed faces of wall with Class 5 Applied Finish Coating.
The panel color shall be per Federal Color Chart, Federal Standard No. 595C color _____.
(3) The post and cap color shall be per Federal Color Chart, Federal Standard No. 595C color _____.

SUMMARY OF FOUNDATIONS AND WALL QUANTITIES								Table Date 1-01-14
WALL NO.	STATION TO STATION		FOUNDATION (4)	TOP OR SIDE INSTALLED (T, S)	TOP OF WALL ELEV. (FT)	BOTTOM OF WALL ELEV. (FT)	POST LENGTH (FT)	AREA (SF)

LIMITS OF ANTI-GRAFFITI COATING (5)				Table Date 1-01-14
WALL NO.	STATION TO STATION	FRONT FACE/ BACK FACE/ BOTH (6)	MINIMUM HEIGHT (7)	AREA (SF)

7 Step Noise Barrier Design Process

➢ Step 6: Geotechnical Investigation

- Soils and Foundation Handbook: 3.2.2.4 Sound Walls
  - Sound wall borings shall be taken at a maximum interval of one per 500 feet of the wall, as close to the wall alignment as possible. Extend borings below the bottom of the wall to a depth of twice the wall height or 30 feet, whichever is less. Increase the boring frequency in variable locations and areas of suspected weak soils such as wetlands, filled wetlands, etc.
  - Sampling and in-situ testing criteria are in accordance with ASTM D-1586.

7 Step Noise Barrier Design Process

➢ Step 7: Design the noise barrier

- Precast Noise Barriers: Standard Index (SI) 5200
- CIP Combination Traffic Railing/Noise Barriers: SI 5210 through 5215
- Structures Design Guidelines, Section 3
- Soils and Foundation Handbook

Maximum Noise Barrier Heights*

- Ground mounted outside the clear zone: 22’
  - Must be shielded if within the clear zone
- Bridge or retaining wall/structure mounted: 8’
- Shoulder mounted noise barriers on embankments: 14’

** Per PPM Chapter 32. Design variation required when noise barriers exceed these heights.*

Precast, Ground Mounted Noise Barriers

The post is pre-cast off-site

Precast, Ground Mounted Noise Barriers

The panels are pre-cast off-site

Precast, Ground Mounted Noise Barriers

Overhead crane with auger to drill post hole

Precast, Ground Mounted Noise Barriers

Post is held in place by template until grout hardens

Precast, Ground Mounted Noise Barriers

Post being held in place while work continues

Precast, Ground Mounted Noise Barriers

Panel being set in between posts

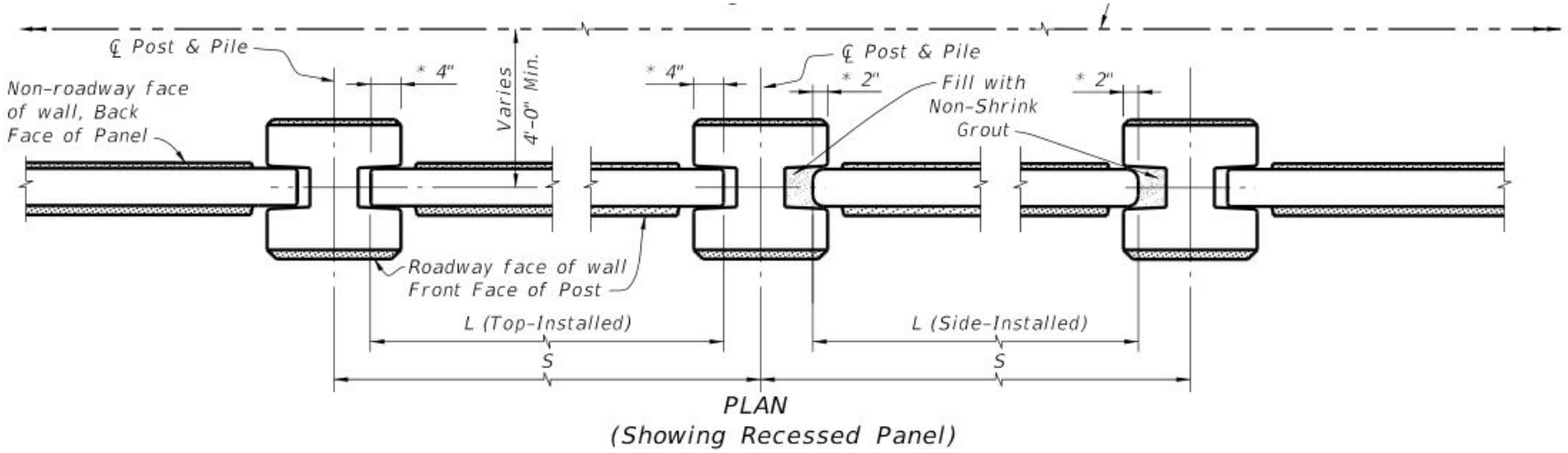
Ground Mounted, Precast Noise Barriers

- Construction Issues:
  - Leveling of any swales and additional space for cranes
  - Consideration of overhead and subsurface utilities
  - Traffic control required for off-loading of posts and panels

Designing Precast Noise Barriers (SI 5200)

Recessed Panels

- Allows textures on both sides of barrier



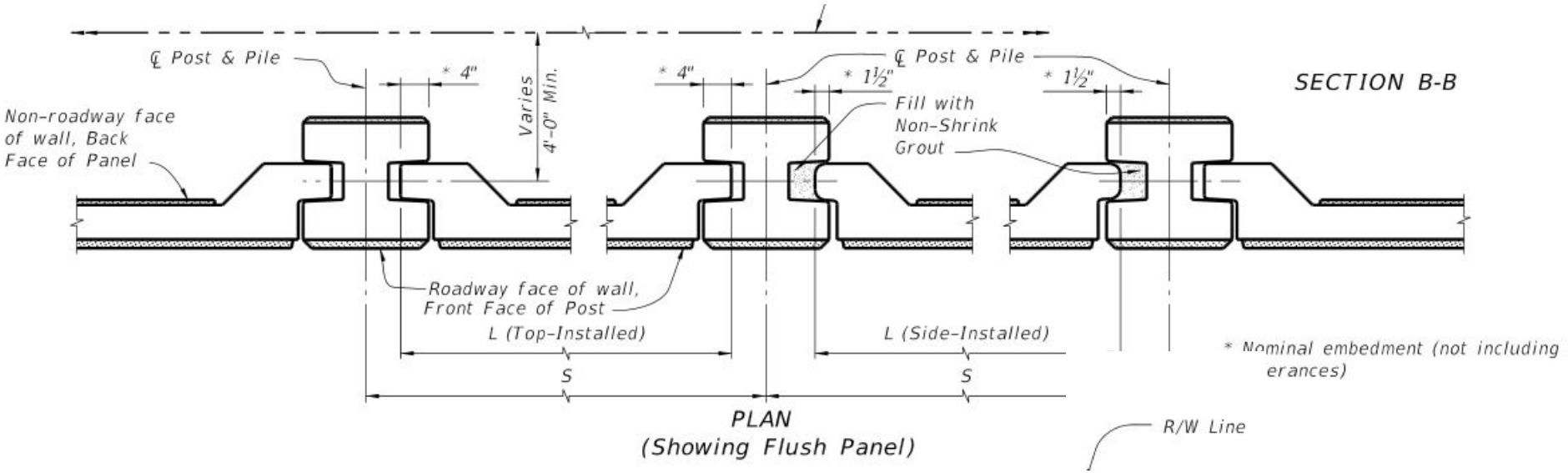
Designing Precast Noise Barriers (SI 5200)

Precast noise barrier with recessed panels and textures on both sides

Designing Precast Noise Barriers (SI 5200)

Flush Panels

- Allows textures on both sides, but back side may be limited



Designing Precast Noise Barriers (SI 5200)

Precast noise barrier with flush panels and texture on roadway side

Designing Precast Noise Barriers (SI 5200)

- Wind loading criteria per Tables 1B, 2B, 3B of SI 5200

TABLE 1B - PILE LENGTHS (Feet) - WIND SPEED = 110 MPH

WALL HEIGHT (Feet)	10'-0" POST SPACING								20'-0" POST SPACING							
	H-POSTS				CORNER POSTS				H-POSTS				CORNER POSTS			
	SOIL 1		SOIL 2		SOIL 1		SOIL 2		SOIL 1		SOIL 2		SOIL 1		SOIL 2	
	30" ∅	36" ∅	30" ∅	36" ∅	30" ∅	36" ∅	30" ∅	36" ∅	30" ∅	36" ∅	30" ∅	36" ∅	30" ∅	36" ∅	30" ∅	36" ∅
12	11	11	11	10	10	9	9	9	15	14	14	13	13	12	12	12
13	12	11	11	10	11	10	10	9	16	15	15	14	14	13	13	12
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21	16	15	15	14	14	13	13	12	21	19	19	18	18	17	17	16
22	16	15	15	14	14	13	13	12	21	20	20	18	19	17	17	16

Designing Precast Noise Barriers (SI 5200)

- Soils and Foundation Handbook: Appendix B – Design Guidelines for Auger Cast Piles
  - Normal foundation diameter = 30 inches
  - Generally limit foundation depth to 25-30 feet
  - Use Load Factor in accordance with latest AASHTO LRFD Bridge Design Specifications

Ground Mounted, Cast in Place (CIP) Noise Barriers

CIP noise barrier on continuous spread footing foundation

Masonry Noise Barriers

Masonry noise barriers on spread footing foundations (photos are not of the same wall)

CIP and Masonry Noise Barriers

- May Be Justified On Projects:
  - With shorter height noise barriers (max of 12’-14’)
  - Where construction access is difficult
  - When quantities are not enough to justify precast noise barriers
  - Where underground or overhead utilities restrict precast noise barriers

Shoulder/Structure Mounted Noise Barrier

8’ Retaining Wall Mounted Noise Barrier w/ Junction Slab

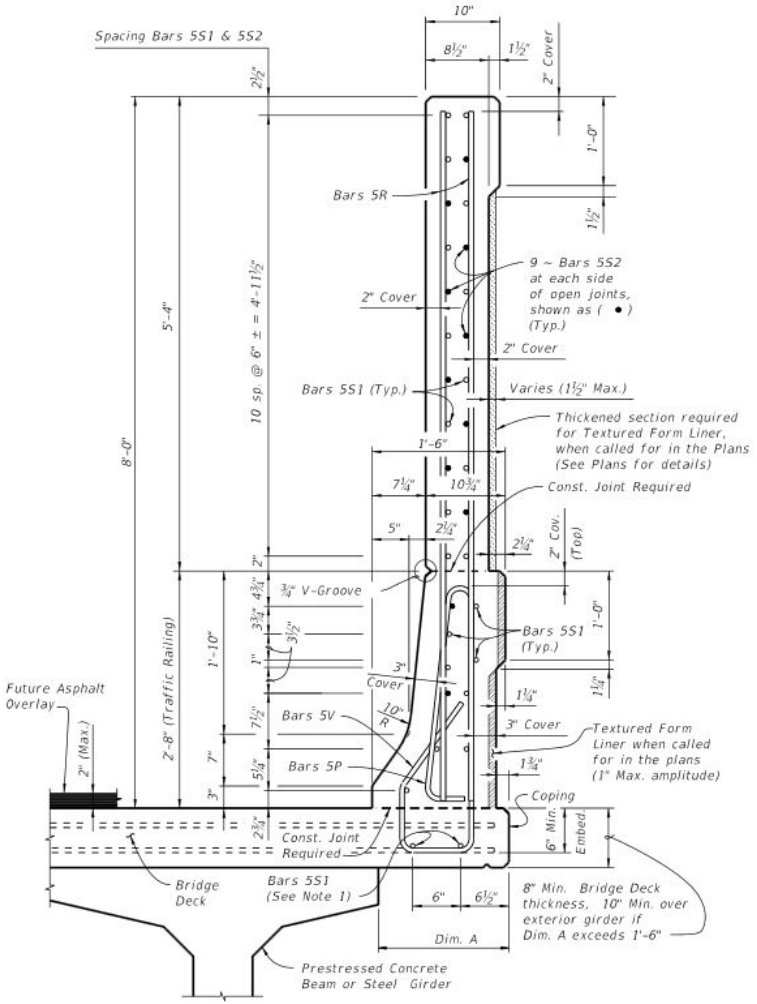
Shoulder/Structure Mounted Noise Barrier

- Includes both bridge and MSE/retaining wall (FDOT Standard Index 5210)
  - 8’ maximum height
  - Cast in Place (CIP) Construction

Bridge Structure Mounted Noise Barrier

Designing CIP Noise Barriers (SI 5210 – 5215)

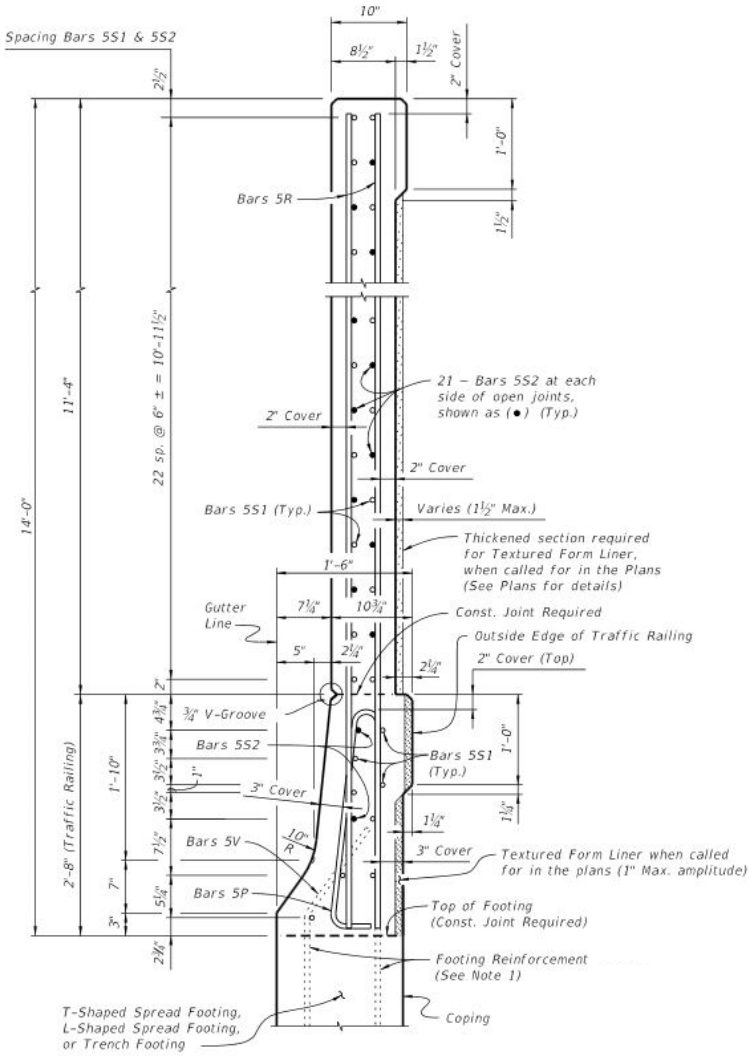
- Standard Index 5210: Traffic Railing/Noise Barrier (8’)



SECTION A-A
TYPICAL SECTION THRU TRAFFIC RAILING/NOISE WALL
(Section Thru Bridge Deck Shown, Section Thru Approach Slab, Junction Slab or Footing Similar)

Designing CIP Noise Barriers (SI 5210 – 5215)

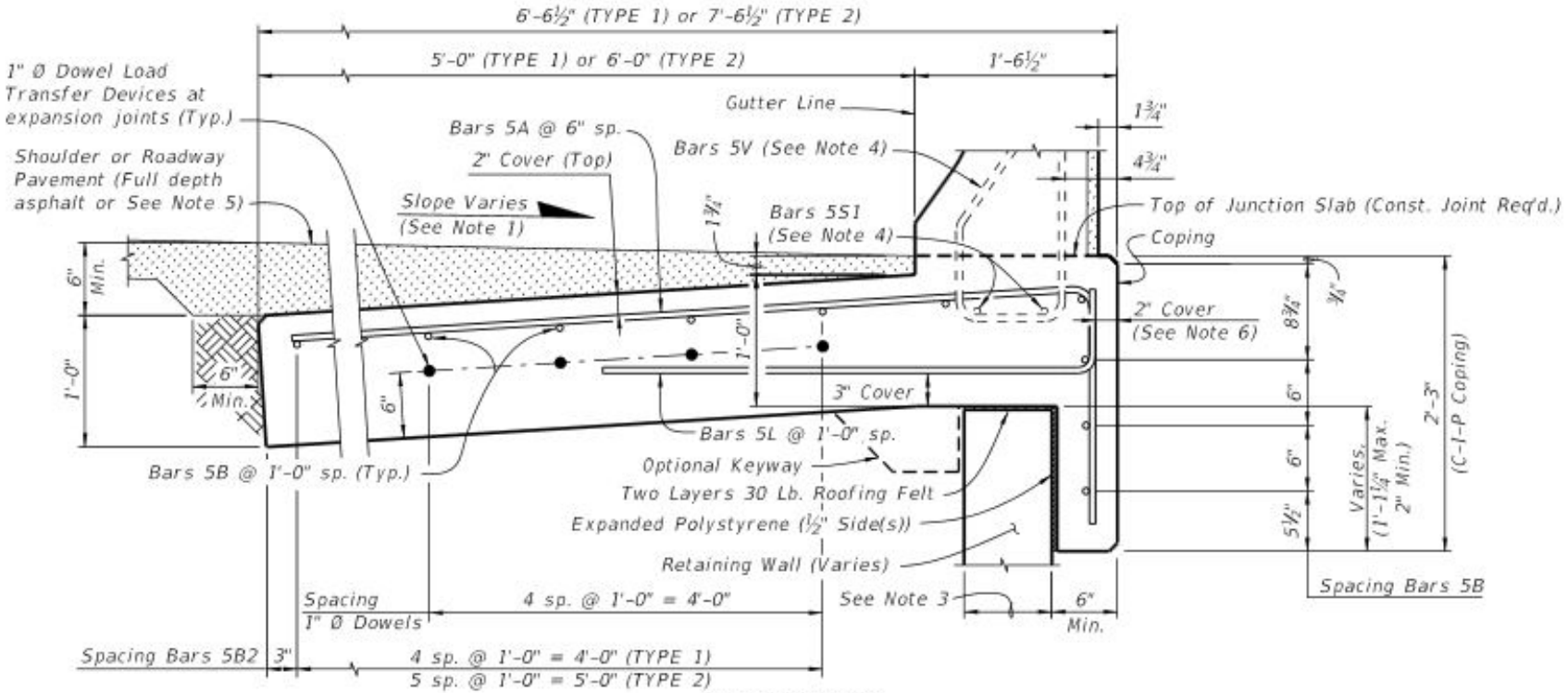
- Standard Index 5211: Traffic Railing/Noise Barrier (14’)



SECTION A-A
TYPICAL SECTION THRU TRAFFIC RAILING/NOISE WALL

Designing CIP Noise Barriers (SI 5210 – 5215)

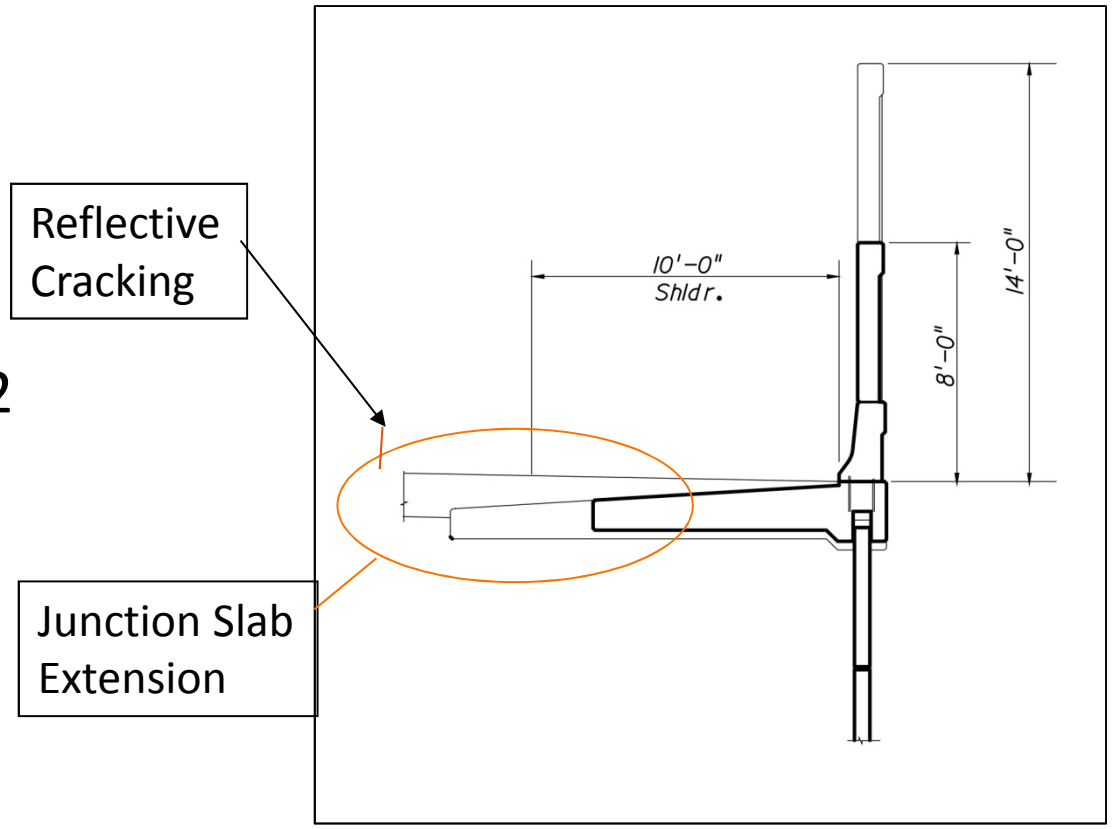
- Standard Index 5212: Traffic Railing/Noise Barrier (8') Junction Slab



SECTION B-B
TYPICAL SECTION THRU JUNCTION SLAB AND RETAINING WALL

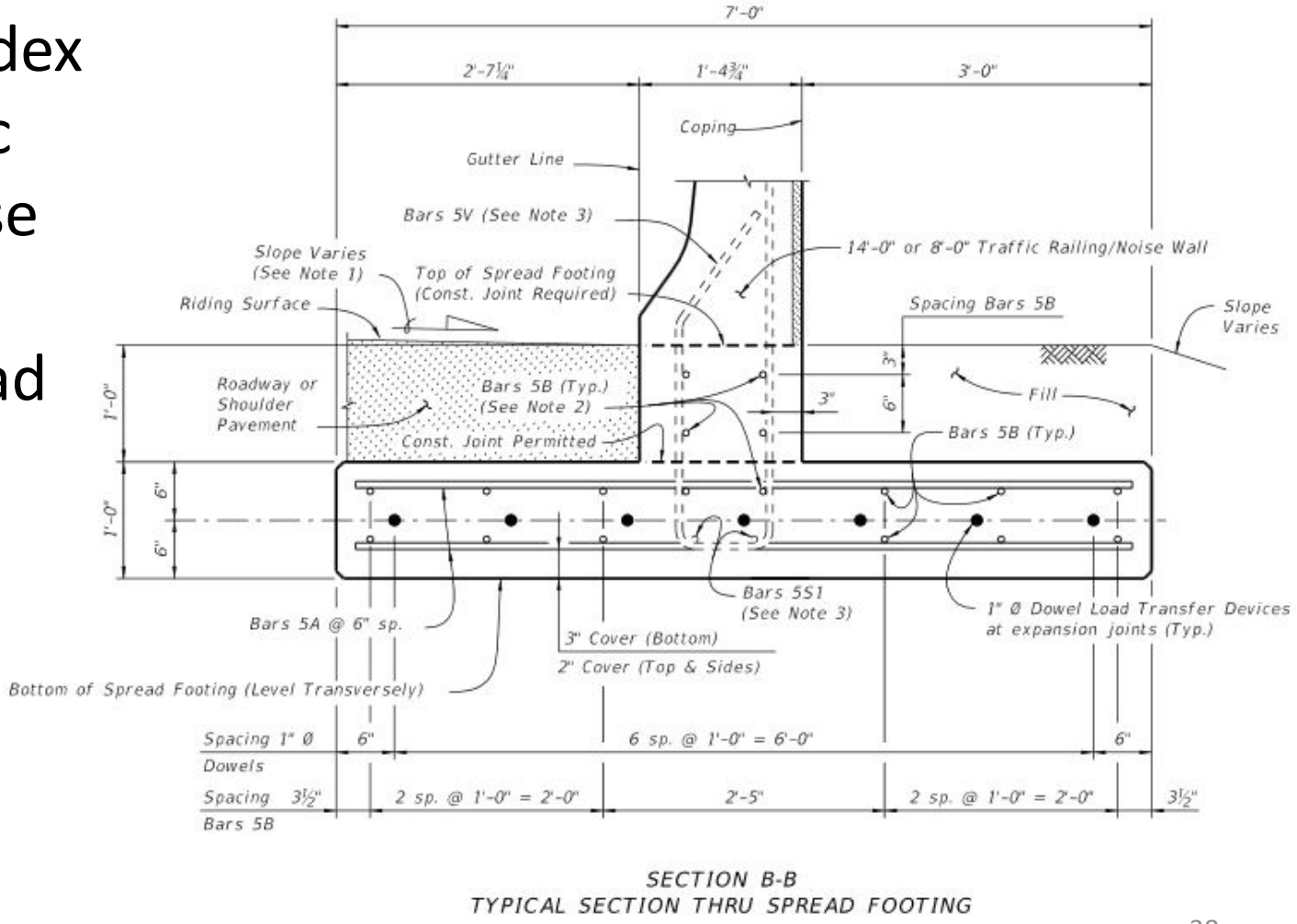
Special Designs – Noise Barriers Taller than 8’ on MSE Retaining Walls

- CIP Retaining wall/crash tested noise barrier combination
- Standard Index 5211/5212
- Problems:
  - Junction slab too large
  - Variation is required



Designing CIP Noise Barriers (SI 5210 – 5215)

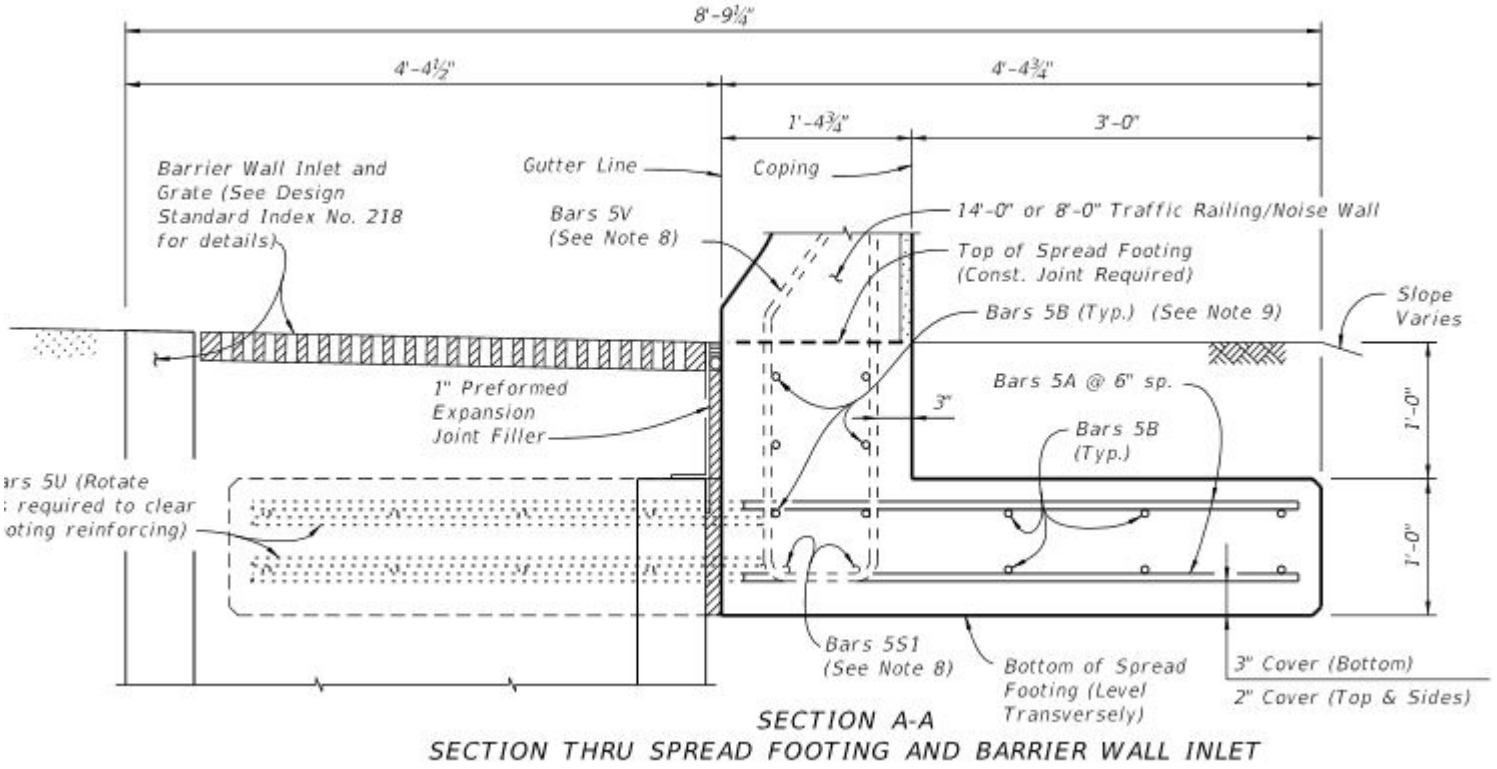
- Standard Index 5213: Traffic Railing/Noise Barrier T-Shape Spread Footing



SECTION B-B
TYPICAL SECTION THRU SPREAD FOOTING

Designing CIP Noise Barriers

- Standard Index 5213: Traffic Railing/Noise Barrier T-Shape Spread Footing

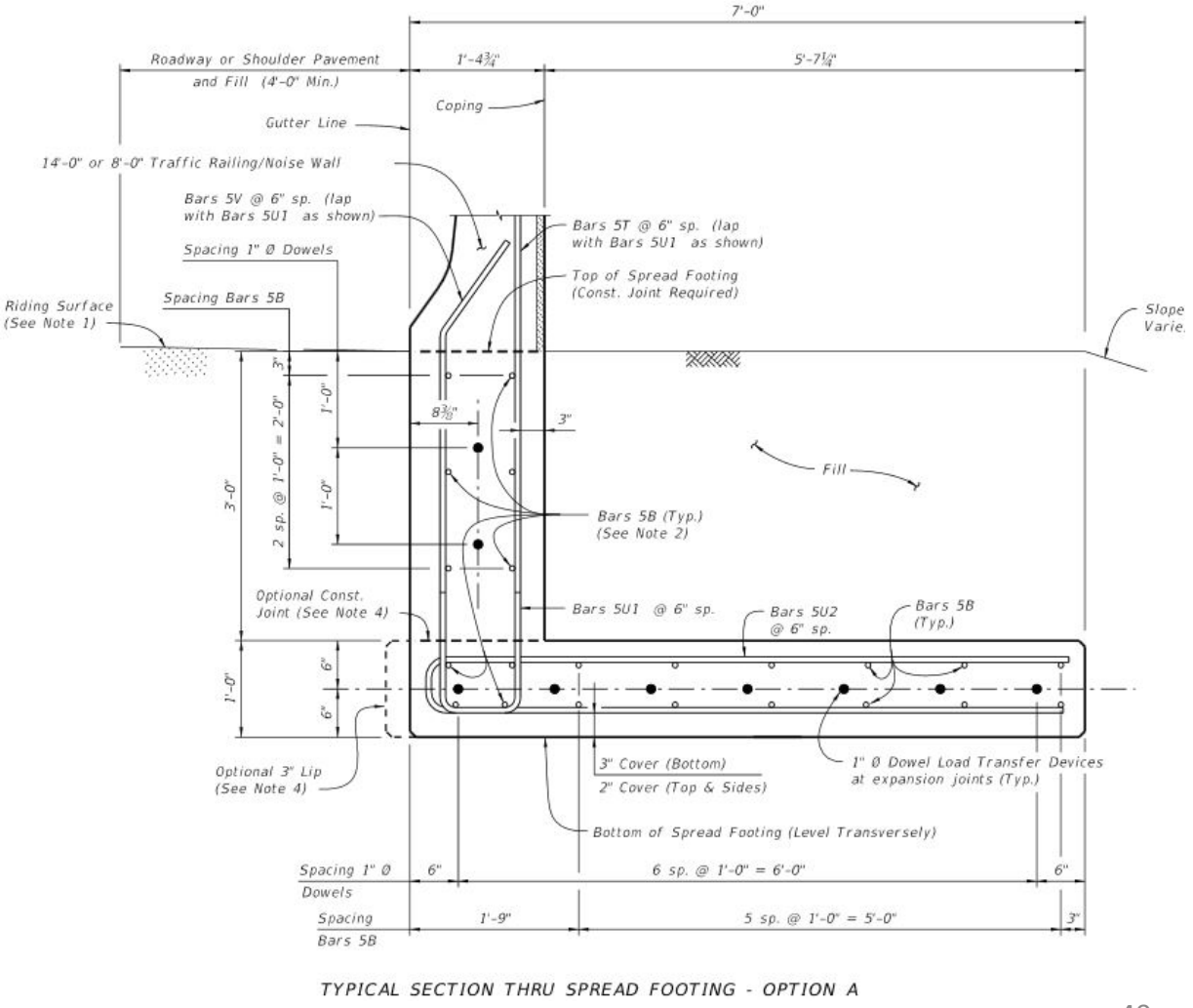


SECTION A-A

SECTION THRU SPREAD FOOTING AND BARRIER WALL INLET

Designing CIP Noise Barriers (SI 5210 – 5215)

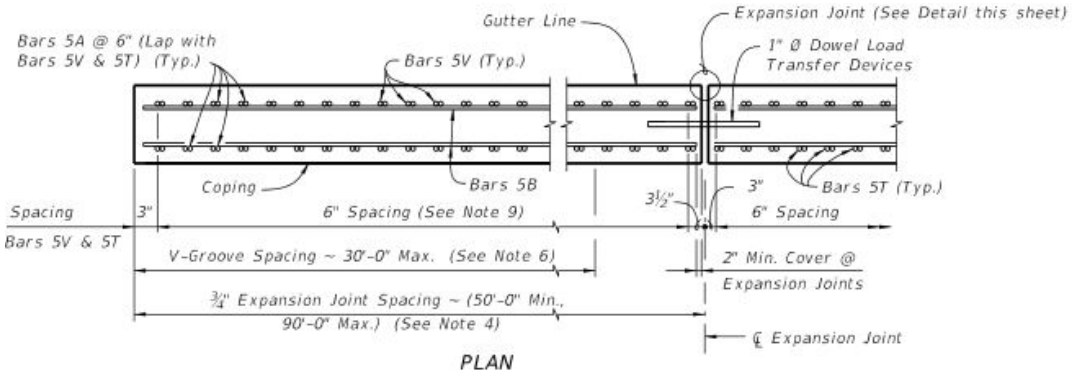
- Standard Index 5214: Traffic Railing/Noise Barrier L-Shape Spread Footing

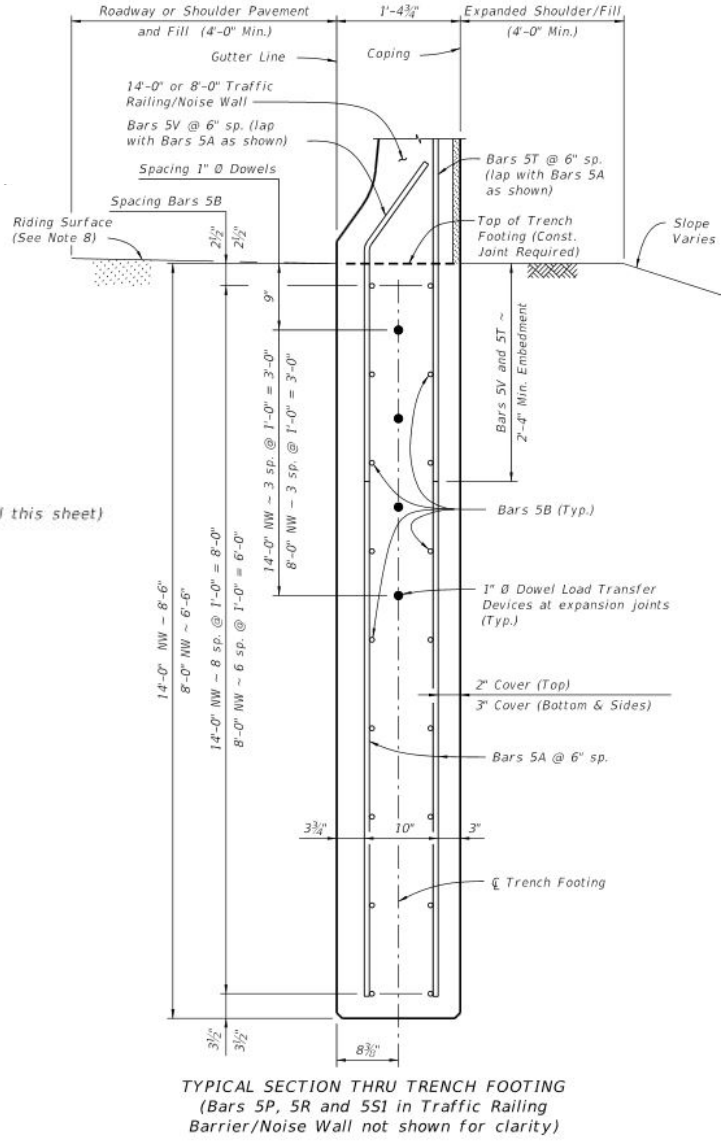


TYPICAL SECTION THRU SPREAD FOOTING - OPTION A

Designing CIP Noise Barriers (SI 5210 – 5215)

- Standard Index 5215: Traffic Railing/Noise Barrier Trench Footing





TYPICAL SECTION THRU TRENCH FOOTING
(Bars 5P, 5R and 5S1 in Traffic Railing Barrier/Noise Wall not shown for clarity)

Special Designs – Overhead Utility Conflict

- Problem: Setting precast panel with a crane typically requires large overhead envelope

Parallel overhead utility line

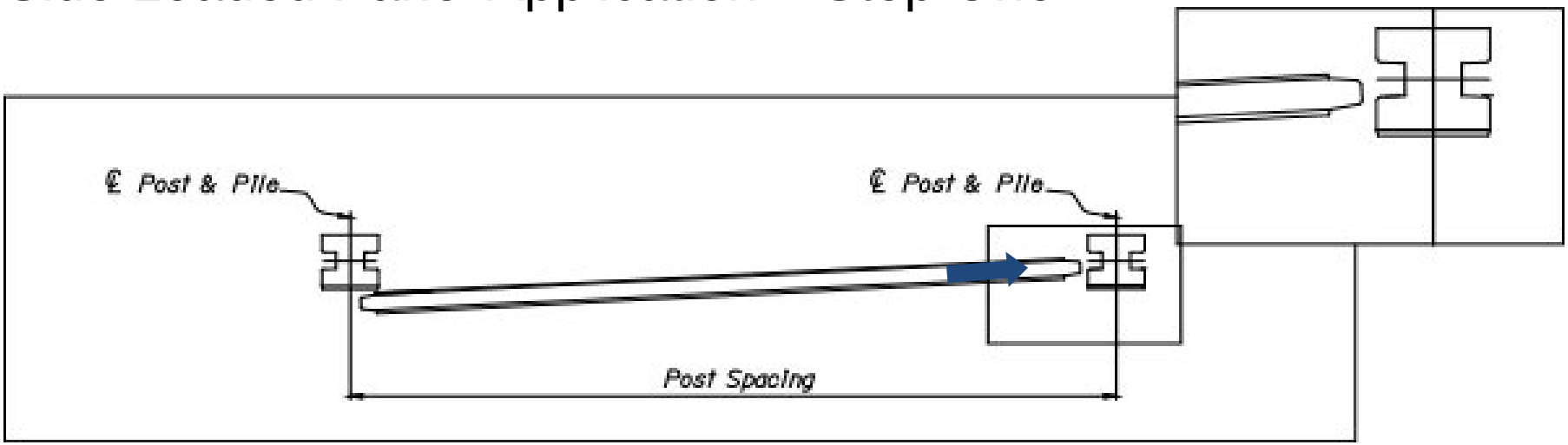
- *Short term construction equipment clearances*
- *Long term wall clearances*
- *Can electric line be relocated or shut down?*

Special Designs – Overhead Utility Conflict

- Low Overhead Equipment

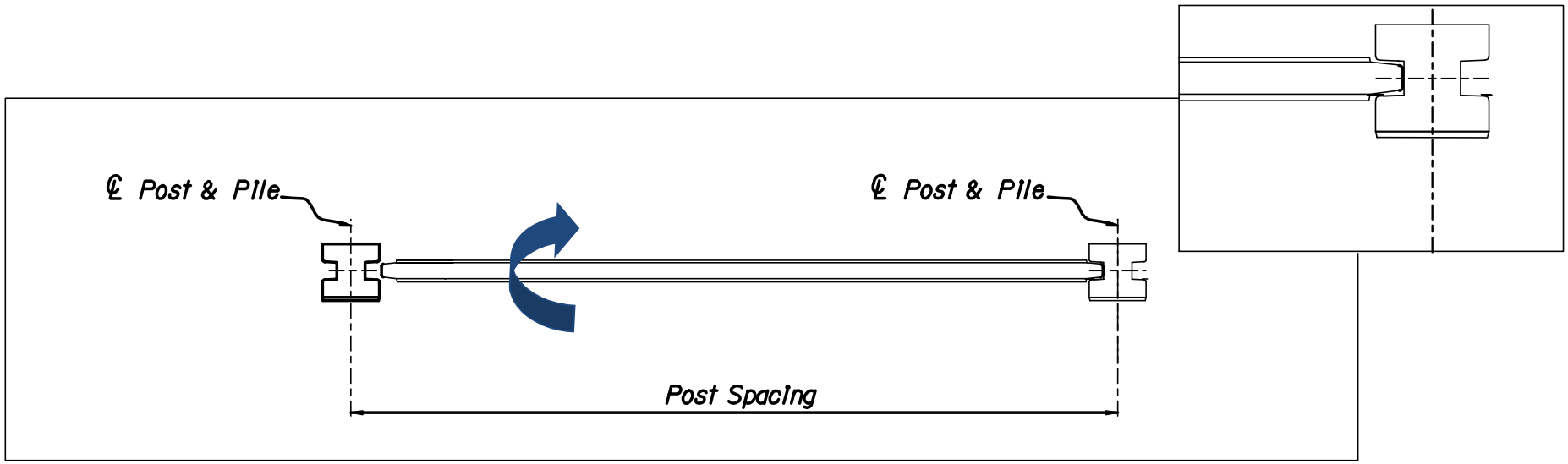
Special Designs – Overhead Utility Conflict

- Side Loaded Panel Application – Step One



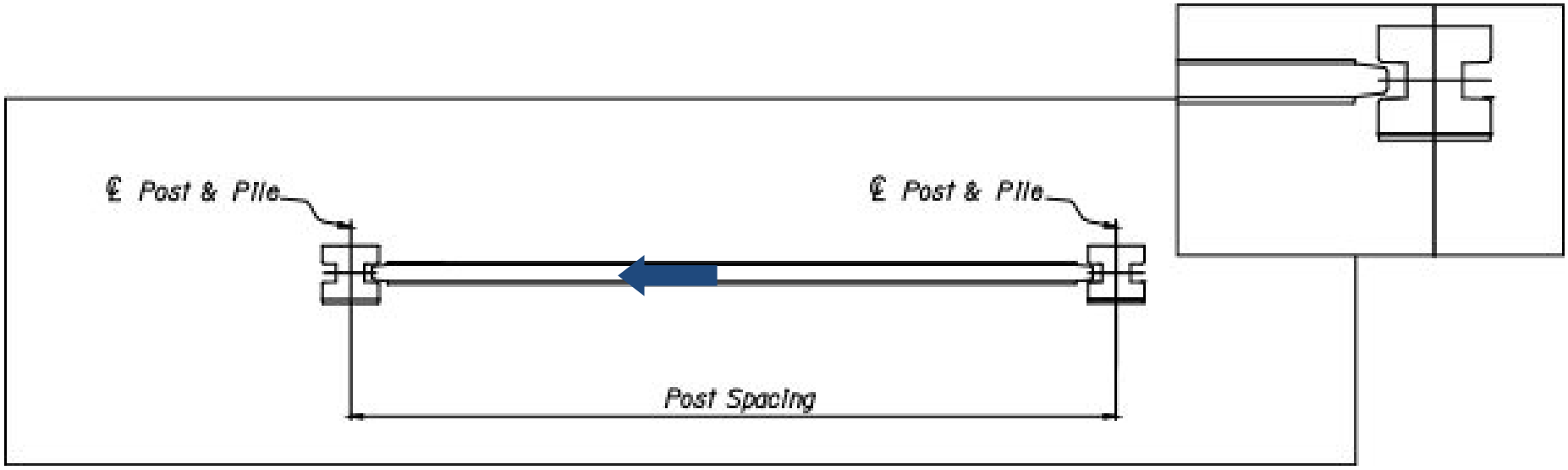
Special Designs – Overhead Utility Conflict

- Side Loaded Panel Application – Step Two



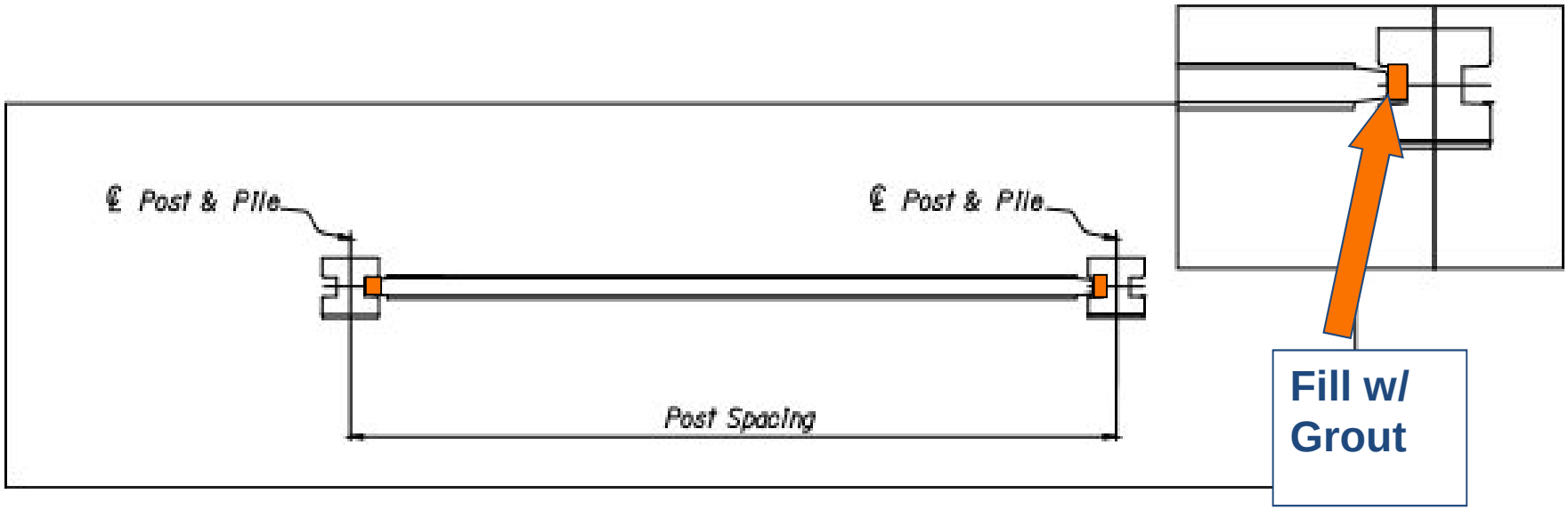
Special Designs – Overhead Utility Conflict

- Side Loaded Panel Application – Step Three



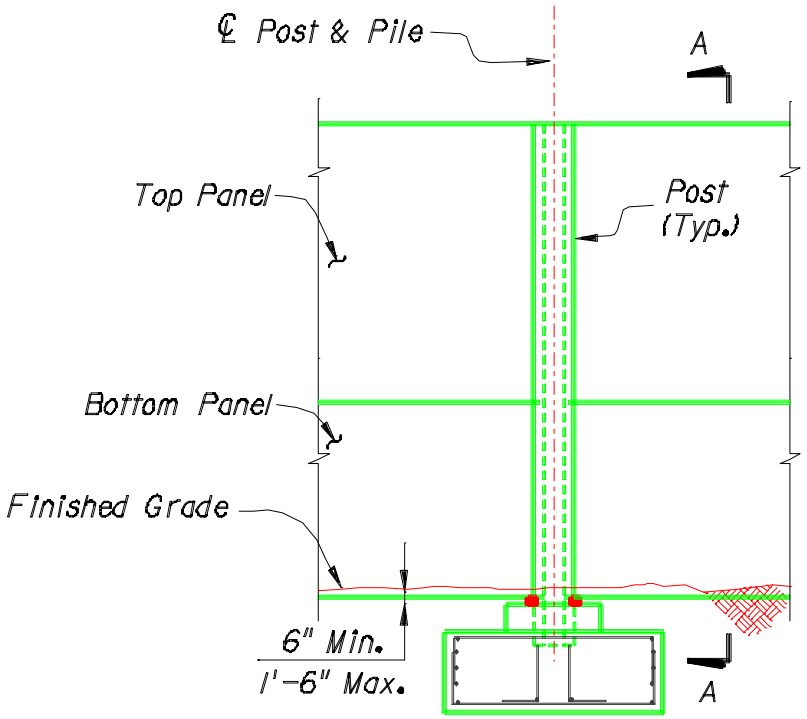
Special Designs – Overhead Utility Conflict

- Side Loaded Panel Application – Step Four

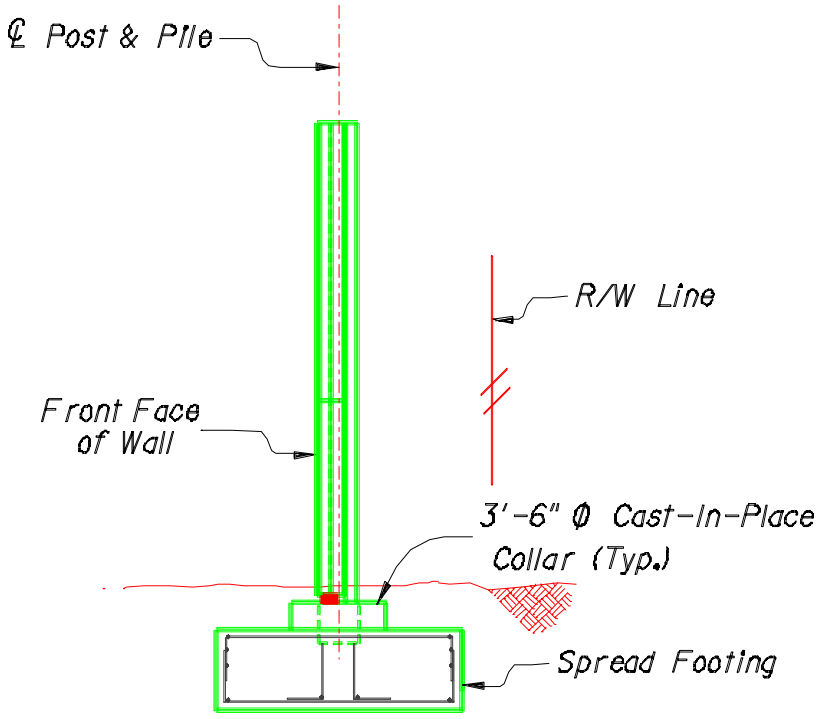


Special Designs – Overhead Utility Conflict

- Spread Footing (Standard Index 5213)



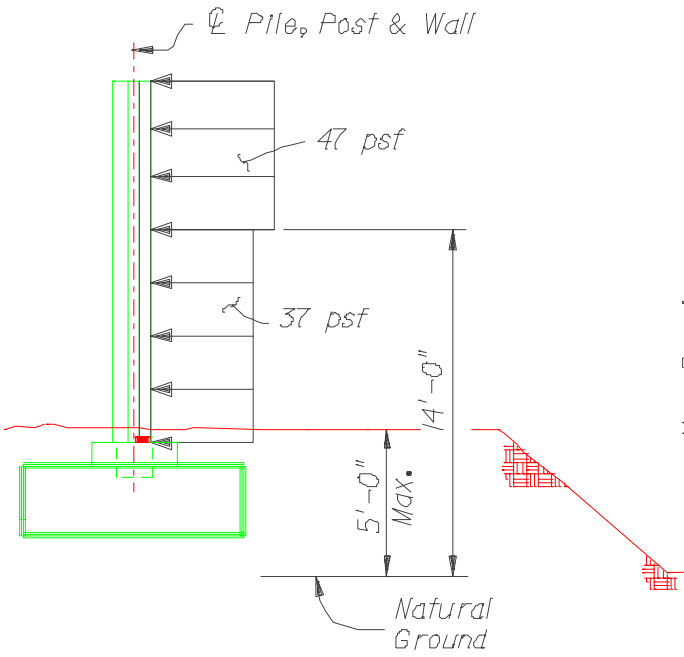
ELEVATION VIEW

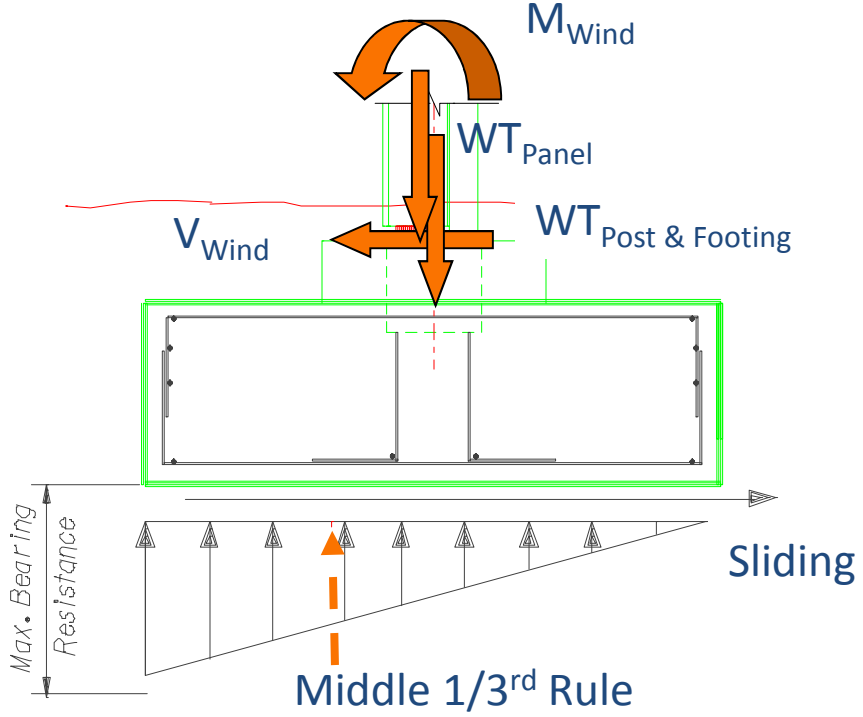


SECTION A-A

Special Designs – Overhead Utility Conflict

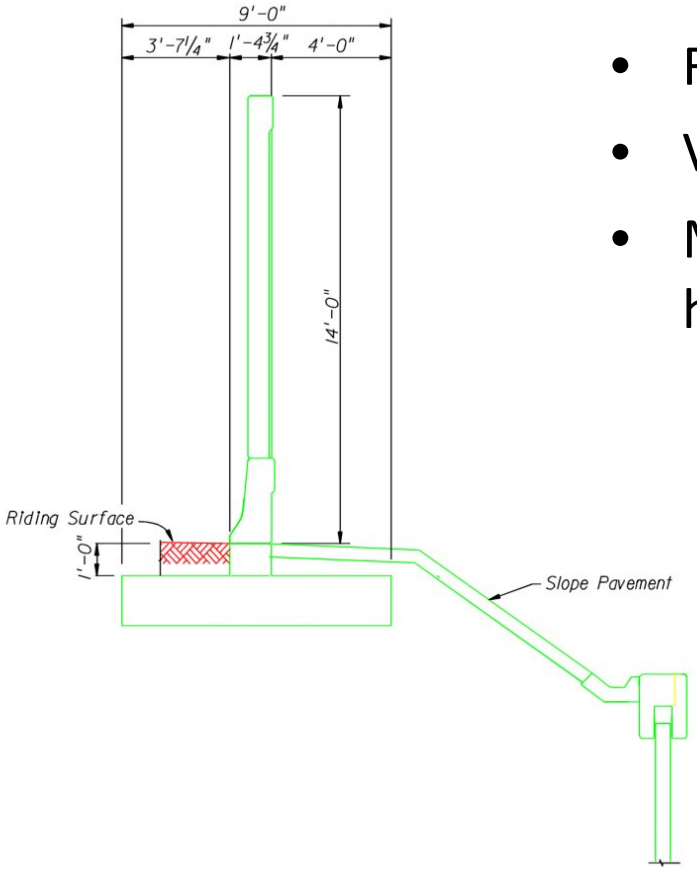
- Spread Footing





$FS)_{Overturning}$ = 1.5 (Group 2)
$FS)_{Sliding}$ = 1.2 (Group 2)
Check Both Wind Directions
Check Global Stability
Compact Soil Per 455-31

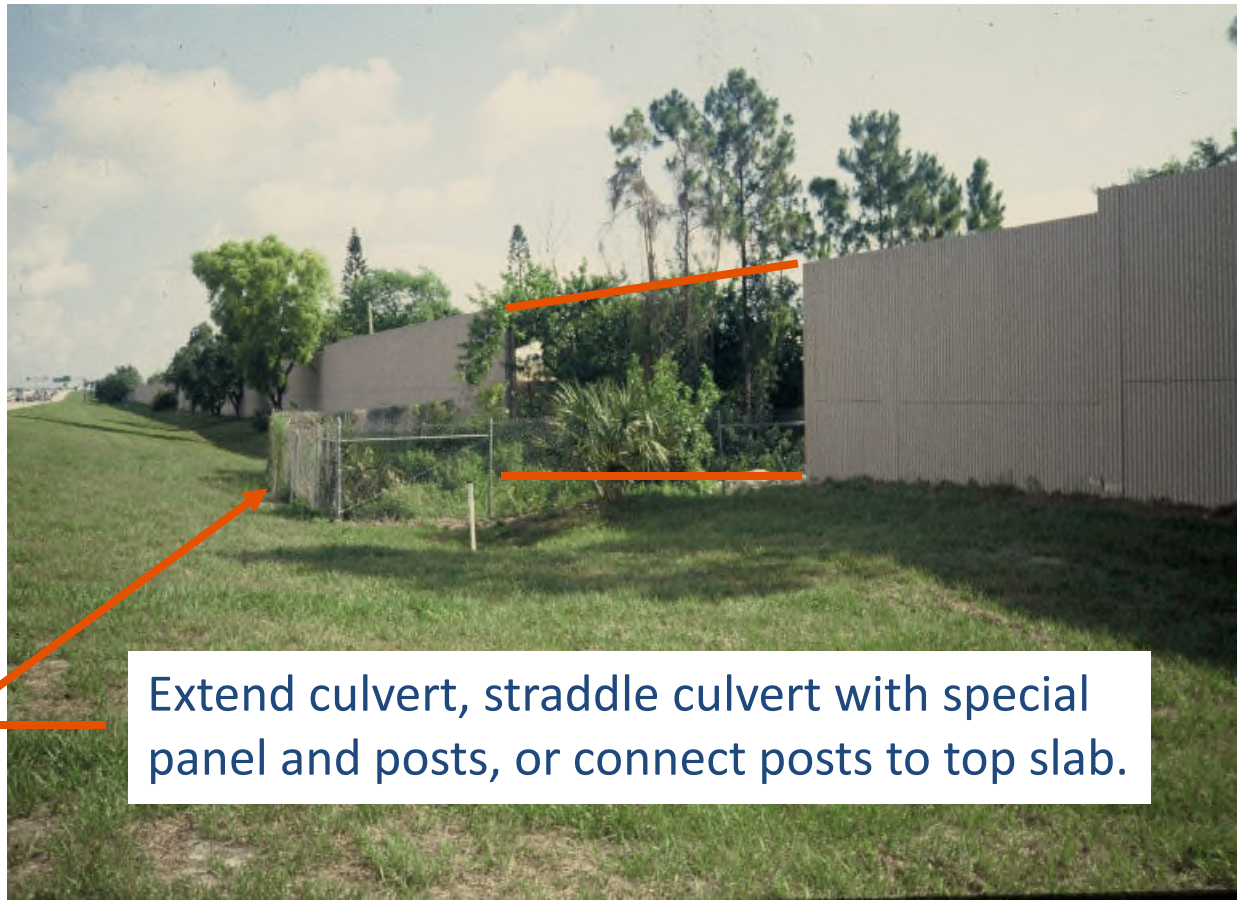
Special Designs – Noise Barriers Taller than 8’ on MSE Retaining Walls



- Rigid shoulder roadway barrier with T footing
- Variance not required
- Modify design for increased wind based on wall height
  - May be considered when space allows offset
  - Cost of increased select fill, slope pavement and partial vs. full height wall

Special Designs – Special Panels

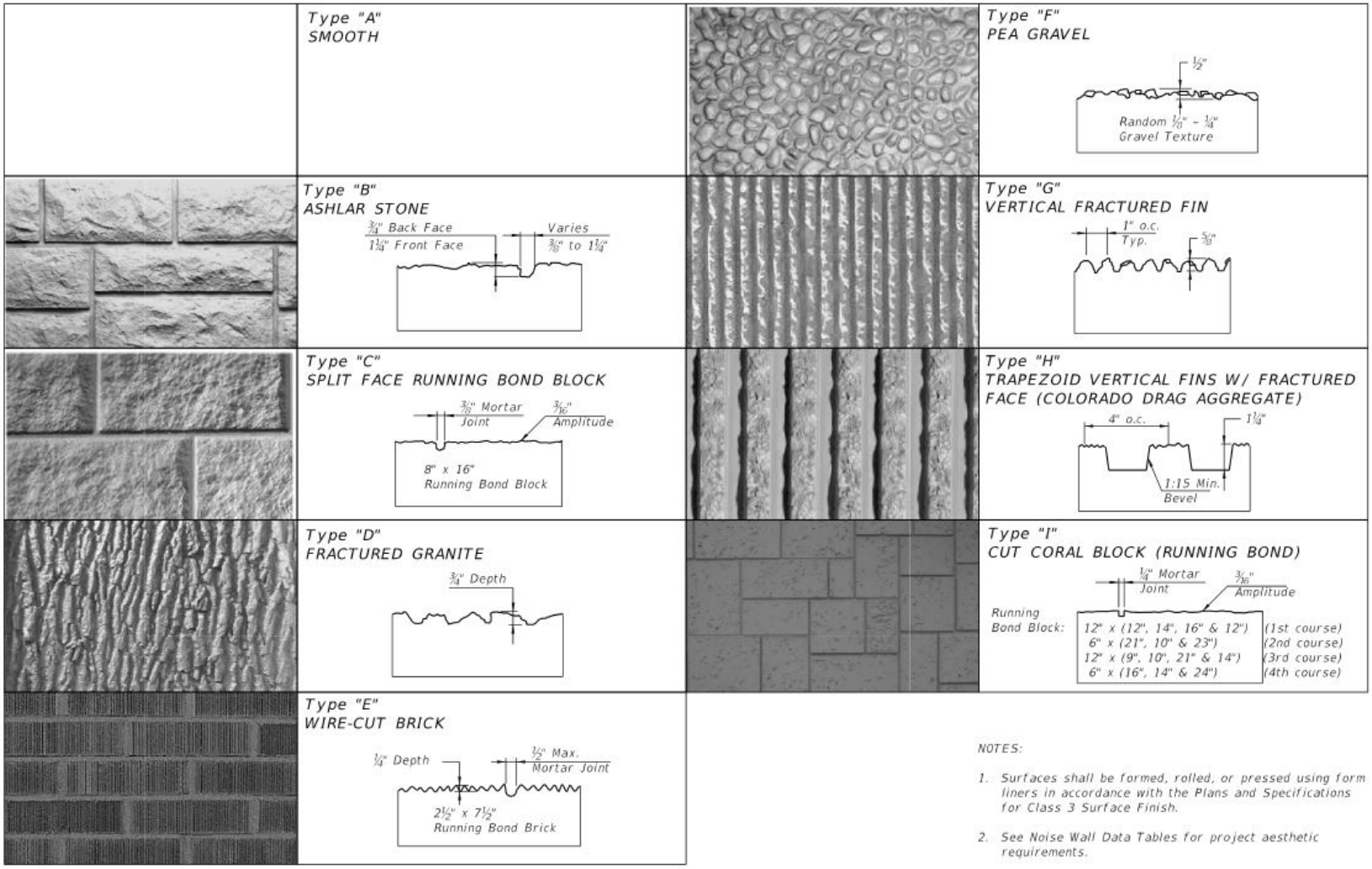
- Culvert Extensions And Special Panels / Posts



Special Designs – Special Panels

- Pedestrian Bridge Overpass

Noise Barrier Aesthetics – Precast Noise Barriers

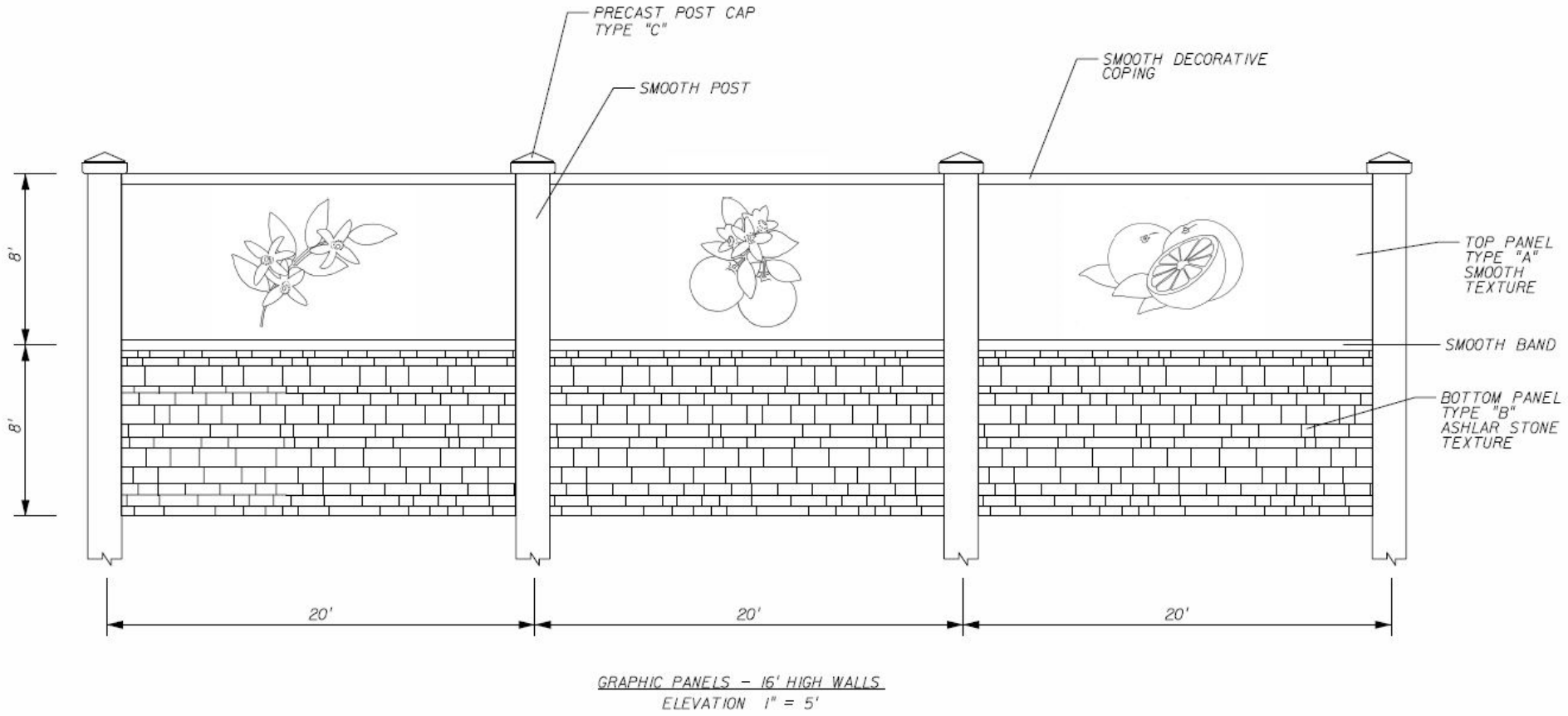


Noise Barrier Aesthetics – Precast Noise Barriers

PROJECT REQUIREMENTS								Table Date 1-01-14
WALL NO. (1)	REQUIRED: (YES/NO)			REQUIRED TEXTURES:				PANEL TYPE (FLUSH/ RECESSED/ EITHER)
	GRAPHICS (1)	COLORED COATINGS (2)	PRECAST POST CAP (3)	PANELS:		POSTS:		
				FRONT FACE	BACK FACE	FRONT FACE	BACK FACE	

(1) See Control Drawings.
(2) Coat all exposed faces of wall with Class 5 Applied Finish Coating.
The panel color shall be per Federal Color Chart, Federal Standard No. 595C color _____.
(3) The post and cap color shall be per Federal Color Chart, Federal Standard No. 595C color _____.

Noise Barrier Aesthetics – Precast Noise Barriers

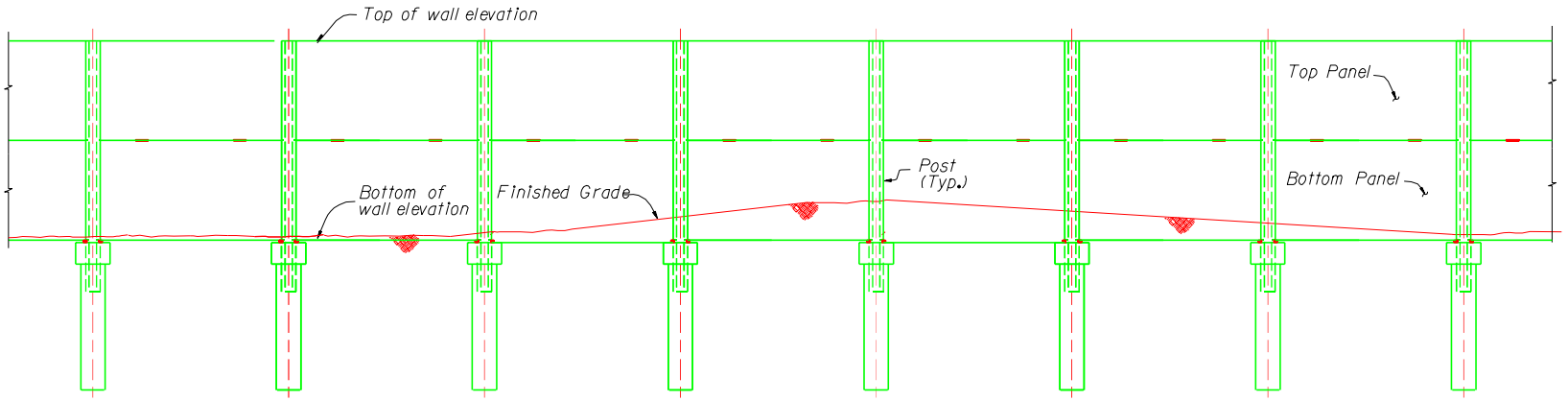


GRAPHIC PANELS – 16' HIGH WALLS
ELEVATION 1" = 5'

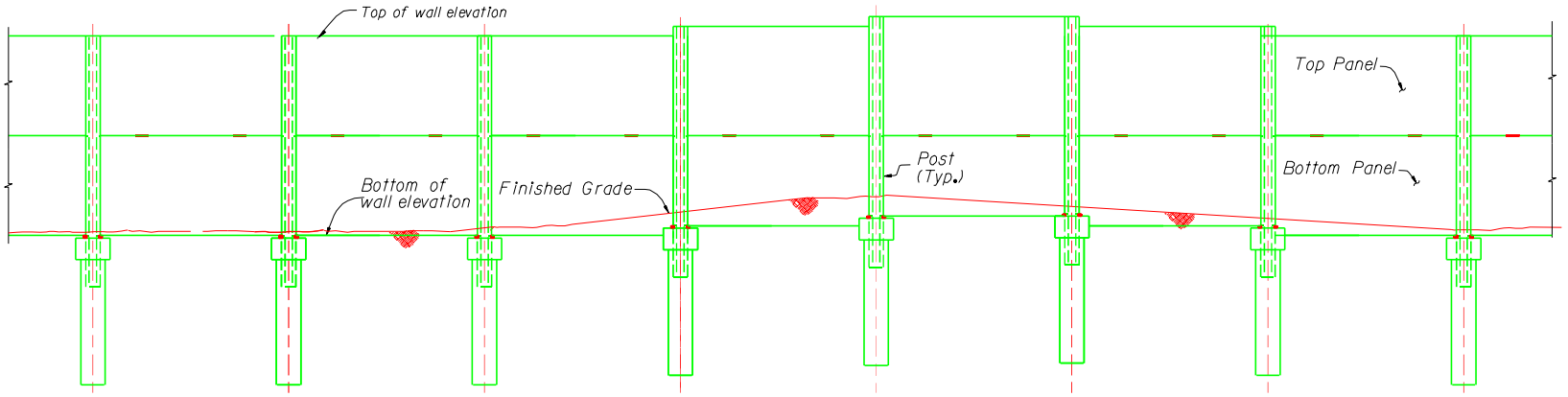
Noise Barrier Aesthetics – Precast Noise Barriers

Single Band vs. Double Band (Horizontal)

Noise Barrier Aesthetics – "Steps" in Noise Barrier



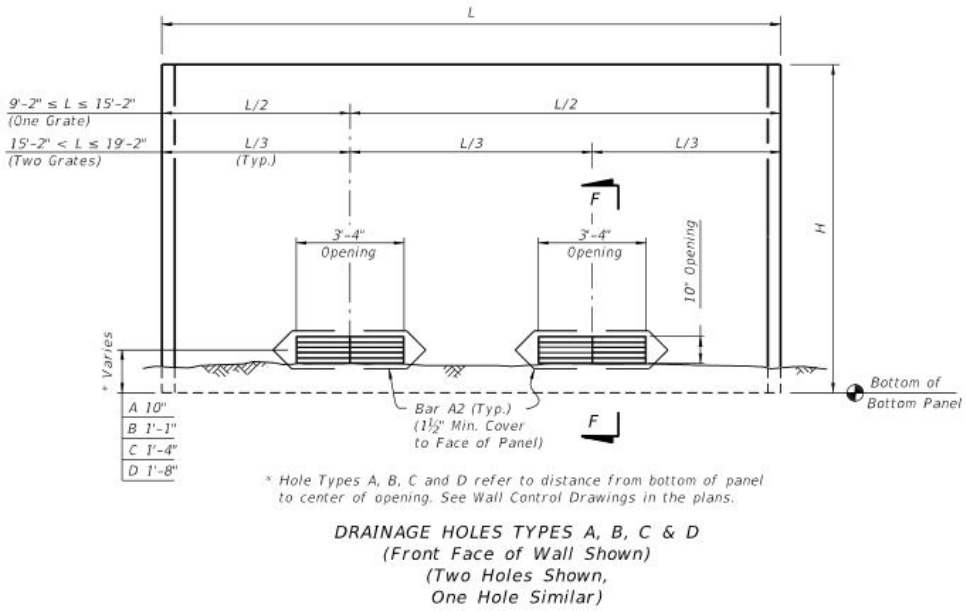
TYPICAL ELEVATION
(Pile/Post Connection Option A Shown)



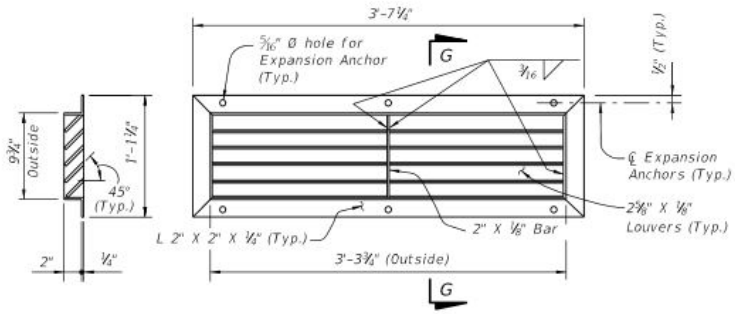
TYPICAL ELEVATION
(Pile/Post Connection Option A Shown)

Other Noise Barrier Design Issues

- Drainage Openings



DRAINAGE HOLES TYPES A, B, C & D
(Front Face of Wall Shown)
(Two Holes Shown,
One Hole Similar)



SECTION G-G

GRATING DETAIL

Other Noise Barrier Design Issues

- Anti-Graffiti Coating
  - In areas of public access (arterial roadways)
  - Sacrificial vs. non-sacrificial

QUESTIONS?

Lesson Eight
Completing the Process: Getting the Noise Barrier through Construction

Plans, Specifications, and Estimates (PS&E)

- PPM, Chapter 14 – “Final Engineering Design Process”
- PPM, Chapter 17 – “Engineering Design Estimate Process”
- PPM, Chapter 20 – “Plans Processing and Revisions”

Test Wall Section

- FDOT Standard Specifications for Road & Bridge Construction, Section 534-6:

  Erect a test wall section not less than 50 feet in length before starting general wall construction at the project site. The Engineer will use the erection of the test wall to verify the Contractor's methods and equipment are sufficient to produce a wall that meets the requirements of the Contract Documents. Build the test wall at a permanent location, as agreed to by the Engineer. If the test wall does not meet the construction tolerances, remove and dispose of it at no expense to the Department. Include the cost of the test wall in the cost of the wall.

Construction Tolerances for Precast Noise Barriers

- Standard Specs, Section 534-5.1
  - Variation from plumb: ± ¼" per 10 feet
  - Panel alignment: ± ¼"
  - Top of panel elevation: ± ¾"
  - Elevation difference of adjacent panels: ± ½"
  - Joint taper over panel length: ± ½"
  - Top of collar elevation: ± ¾"
  - Post Placement:
    - Variation from specified location: ± 1.0"
    - Variation from specified elevation: ± ¼"
  - Continuity of graphics, fracture fins, etc. across joints: ¼"

Shop Drawing Submittal

Standard Specs for Road and Bridge Construction, Section 534-4:

- Submit shop drawings for precast elements, when required, in accordance with Section 5, showing a plan and elevation with the following project specific information:
  - Begin and end wall stations with offsets
  - Horizontal and vertical alignments of wall
  - Panel locations
    - Graphic details and graphic panel locations
    - Drainage panel locations and type
    - Location and length of side installed panels (when required)
  - Post locations and lengths
  - Elevations of top of panel, bottom of panel, and panel joints

Shop Drawing Submittal (Continued)

Standard Specs for Road and Bridge Construction, Section 534-4:

- Existing and proposed ground elevations
- Non-standard precast component details
- Non-standard post and pile connection details
- Lifting devices

534-8: Method of Payment

- The quantity to be paid for will be the plan quantity, in square feet, measured in place, completed and accepted, of the area bounded by the top of the wall (including wall cap) and the bottom of the wall elements without deductions for openings for the beginning to end limits shown in the control drawings.

534-9: Basis of Payment

- Price and payment will be full compensation for all work specified in this Section, including, but not limited to, furnishing all materials and labor required to construct the wall including caps and foundations.

- Payment will be made under:
  - Item No. 534-72- Concrete Noise Wall – per ft^2 (for precast, ground mounted barriers)
  - Item No. 521-7 or 521-8 (For shoulder mounted noise barriers, per ft^2)

"Dear Neighbor" Letter

- Typically sent by CEI or Project Engineer to notify residents when noise barrier construction will occur near their community and what to expect during the process

Maintaining Fence During Construction

QUESTIONS?